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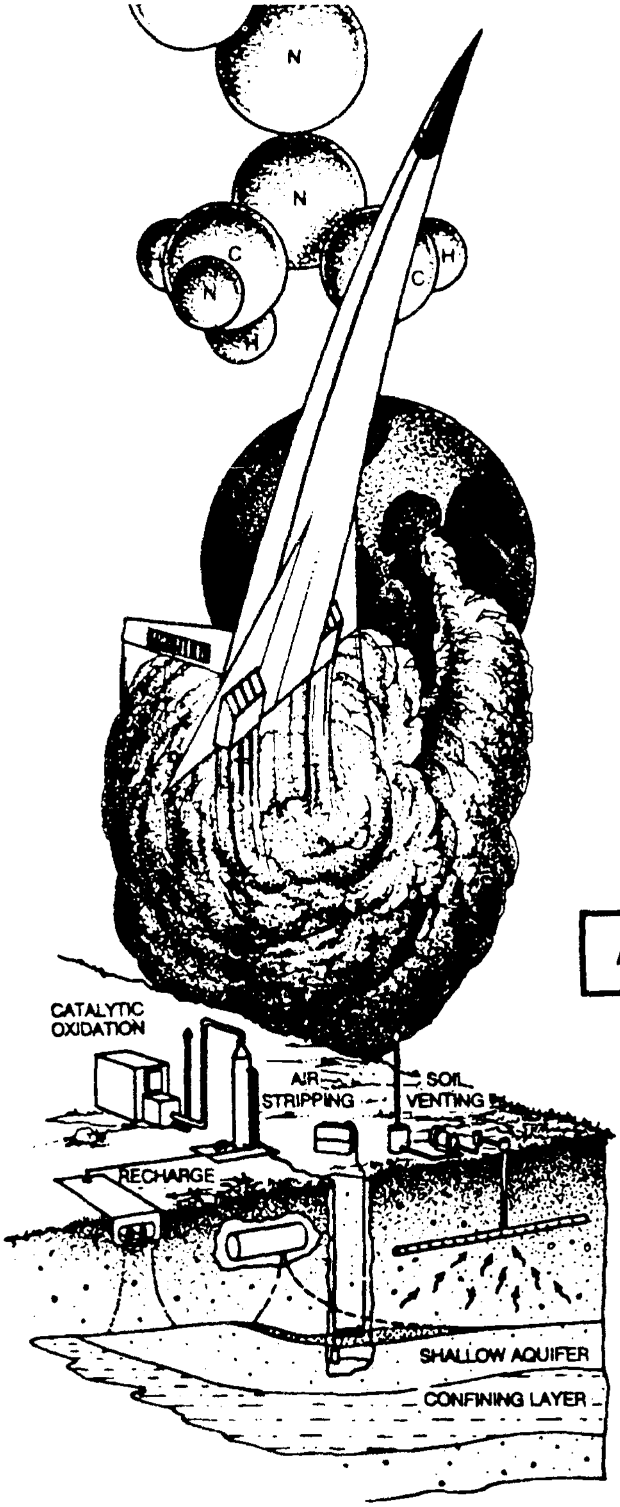
ESL-TR-89-27

SOLVENT EMISSIONS REDUCTION STUDY AT NEWARK AFB, OHIO



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ENVIRONICS DIVISION
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19 ABSTRACT (Continue on reverse if necessary and identify by block number)

The results of Freon 113™ emissions testing performed at Newark AFB are presented. Based on the results, recommendations were made to reduce the emissions from the facility by 250,000 pounds or more. The recommendations focus on improving the solvent recovery efficiency of the carbon adsorption vapor recovery systems located onsite, and reducing emissions from sources vented directly to the outside.

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EXECUTIVE SUMMARY

A. OBJECTIVE

The objective of this effort was to collect baseline Freon emissions data, and subsequently recommend potential emission control alternatives to minimize Freon emissions that result from routine maintenance and repair operations conducted at Newark AFB, Ohio.

B. BACKGROUND

Newark AFB, Ohio, uses a number of solvents to clean and maintain electronic guidance devices. The solvent most often used in this application is 1,1,2-trichloro-1,2,2-trifluoroethane, a solvent commonly known by the DuPont Company trademark Freon 113™ (hereafter referred to as Freon). Newark AFB purchases large quantities of Freon (nearly 600,000 pounds annually), and in previous years, lost nearly all of it (555,000 pounds) as unrecovered Freon vapor.* Freon is one of a general class of chemicals known as chlorofluorocarbons (CFCs). Scientific evidence strongly suggests that CFC emissions are responsible for the depletion of the protective ozone layer surrounding the earth's atmosphere. For this reason, the U.S. Air Force must reduce and eventually eliminate CFC emissions from Air Force facilities.

Several steps have been taken to reduce the quantity of Freon emitted from the more than 100 emission point sources at Newark AFB. For example, the recovery of solvent vapors emitted from more than half of the point sources at the facility is achieved with limited success by the use of two carbon adsorption (CA) systems. The performance of the recovery system in the past has been marginal at best, primarily due to an inadequate regeneration schedule.

In addition to the carbon adsorption systems, continuously operated distillation equipment is used to purify recovered liquid Freon for reuse. However, military specifications require that most processes use only ultrapure solvent, so only Freon that is not significantly contaminated may be recycled. The remainder is sold to an offsite waste handling facility.

C. SCOPE

To develop methods of reducing Freon emissions from the cleaning and maintenance activities at Newark AFB, baseline emissions testing at key sites was performed. The data

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*This quantity was derived in an earlier solvent inventory study performed to identify significant Freon emission sources at Newark AFB (1). This study took into consideration the quantity of Freon purchased in the 1-year period studied, the change in the quantity of Freon stored onsite, and the quantity shipped offsite as a hazardous waste and sold to a solvent reclamation facility. The quantity of Freon lost due to evaporation (555,000 pounds [252,272 kg]) was only slightly less than the quantity purchased (596,000 pounds [270,909 kg]).

collected was evaluated to identify primary emission sources, and ventilation system inefficiencies. The results of this evaluation were used to develop several Freon emission reduction strategies.

D. APPROACH

This project was conducted in two steps. Step one involved a source identification study and a Freon emissions survey. Such engineering parameters as temperature, pressure, flow rates, and Freon concentrations were measured. This information was required to accurately determine the Freon emissions profile of Newark AFB, as well as to facilitate the identification of various emission reduction strategies. Step two of this project consisted of reducing the data collected in step one, and developing and evaluating a number of Freon emission control strategies.

E. TEST DESCRIPTION

Three principal measurements were performed during this test series. The first was a measurement of air flow rates through exhaust ducts. The second measurement was the linear flow rate at the front faces and access ports of process booths connected to the CA systems. The third measurement was to determine Freon concentration variations in the duct over an extended period of time. At two of the test sites (CA 3 and CA 4), an additional measurement was performed to determine 1,1,1-Trichloroethane (TCA) concentration variations. TCA is occasionally used in the process booths connected to the carbon adsorption systems.

F. RESULTS

The emission test results obtained were in good agreement with results obtained from the Freon emission inventory study performed a month prior to testing. Thus, the confidence level in the data collected is high. Several Freon emission reduction strategies were identified based on these results which, if implemented, will result in a Freon emission reduction of more than 60 percent.

G. CONCLUSIONS

From the data collected in this test effort (presented in Section III) and the engineering evaluation results (presented in Section IV); the following conclusions can be drawn:

- The quantity of Freon emitted from the Peacekeeper, Refurbishing, and Clean Room 12 areas total more than 54,432 kg (120,000 pounds) per year; thus emissions from these areas should be targeted for major reduction.
- The emission sources not vented from process areas should be placed in hoods vented to a solvent vapor recovery system.
- The current carbon adsorption system regeneration schedules are inadequate. This is discussed fully in Section IV.
- The test results are in general agreement with the results obtained from the Newark solvent chemical inventory survey performed prior to testing (1).

- The implementation of the recommendations made in this report should result in an emissions reduction of more than 113,400 kg (250,000 pounds) annually.

H. RECOMMENDATIONS.

The recommendations made are of two types: those that can be adopted almost immediately and those that will take some time. These "short-term" and "medium-term" recommendations are presented separately. The medium-term recommendations are

- Significant emissions from the Peacekeeper area should be eliminated by connecting the source exhaust ducts from the Peacekeeper area to the CA 3/CA 4 network.
- Under current operations, CA 4 is significantly underutilized compared to CA 3, which is operating near maximum capacity. It is recommended that Newark AFB either connect the Peacekeeper area exhaust ducts to CA 4, or offload most of the CA 3 sources to CA 4, and connect the Peacekeeper exhaust ducts to CA 3.
- Some flow balancing will be required after the sources are integrated to ensure that sufficient ventilation air passes through each source.
- A separate solvent vapor recovery system should be installed to control emissions from the Refurbishing and Clean Room 12 areas.
- The emission sources that are currently uncontrolled (i.e., degreasers and ultrasonic cleaners), should be vented to a vapor recovery system. However, the cumulative contribution from these sources could have a significant impact on the recovery system operation. Thus, after they are vented, the Freon emissions from these sources should be quantified to assess their potential impact on vapor recovery system operations.
- A means of determining Freon evaporation rates in the significant emission source areas (i.e., Peacekeeper, Refurbishing/Clean Room 12, Clean Room 3) should be installed. In this way, the impacts of changes in operating areas on CA bed performance can be determined.

The short-term recommendations are

- Feedback control loops should be installed at the exits of both CA systems to eliminate the possibility of emitting Freon vapor into the environment due to CA bed breakthrough.
- CA systems 3 and 4 should be converted from split-flow operation to single-bed operation.
- Until feedback control loops are installed in the CA bed effluents, new regeneration schedules for CA 3 and CA 4 should be adopted.
- Freon emissions from CA 4 due to the intermittent duty cycle of the point sources vented in CA 4 should be significantly decreased. The most cost-effective means of controlling these emissions is to turn off the 10-hp (7.5 kW) exhaust fan located upstream of the bed during process downtime (i.e., weekends, and second and third

shift). This will reduce the possibility of solvent migration through the bed and subsequent breakthrough.

PREFACE

This report was prepared by Acurex Corporation, Mountain View, California, under Environmental Protection Agency (EPA) Contract No. 68-02-4285, Work Assignments 0/012, 2/038, 2/042. The EPA was funded by Air Force Engineering and Services Center, Engineering and Services Laboratory (AFESC/RDVS), Tyndall Air Force Base, Florida 32403-6001, to conduct this study for the Air Force.

This report summarizes the work done by Acurex Corporation between August 1988 and April 1989. The U.S. EPA Work Assignment Officer was Charles H. Darvin, Air and Energy Engineering Research Laboratory, Research Triangle Park, North Carolina. Mr. Surendra B. Joshi and Dr. Joseph D. Wander, AFESC/RDVS, were the Air Force project officers for this contract.

This report has been reviewed by the Public Affairs Office (PA) and is releasable to the National Technical Information Service (NTIS). At NTIS, it will be available to the general public, including foreign nationals.

This report has been reviewed and is approved for public release.

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GLOSSARY OF TERMS

ACGIH	American Conference of Governmental Industrial Hygienists
Breakthrough	Occurs when solvent laden air is passed through a saturated carbon adsorption bed, at which time the solvent is not collected by the bed; rather, it breaks through and passes into the effluent
CA	Carbon adsorption
CFM	Cubic feet per minute
DQO	Data Quality Objective
Freon	A trademark name for a class of chlorofluorocarbon compounds. In this document, it refers specifically to 1,1,2-trichloro-1,2,2-trifluoroethane
f_{avg}, f_{bar}	Average conversion factor
hp	Horsepower
kg	Kilogram
OSHA	Occupational Safety and Health Administration
Process Area	An area in which cleaning and maintenance processes (such as spraying, flushing, and degreasing operations) occur
Process Booth	An enclosed booth in which cleaning and maintenance activities (such as spraying, flushing, and degreasing operations) occur
Regeneration	A process in which the active sites on carbon that are saturated with solvent are renewed via steam stripping
SCFM	Standard cubic feet per minute. A volumetric flow rate standardized to a specific temperature and pressure
TCA	1,1,1-Trichloroethane
Vented Source	Process booth or area that is equipped with an exhaust duct that is vented either to the outside or to a carbon adsorption system
w.c.	Water column. A common unit of pressure is inches w.c. or inches water column.

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SECTION I
INTRODUCTION

A. OBJECTIVE

The objective of this effort was to collect baseline Freon emissions data, and subsequently recommend potential emission control alternatives to minimize Freon emissions that result from routine maintenance and repair operations conducted at Newark AFB, Ohio.

B. BACKGROUND

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Several steps have been taken to reduce the quantity of Freon emitted from Newark AFB. For example, the recovery of solvent vapors emitted from more than half of the point sources at the facility is achieved with limited success by the use of two carbon adsorption (CA) systems. The performance of the recovery system in the past has been marginal at best, primarily due to an inadequate regeneration schedule.

In addition to the carbon adsorption systems, continuously operated distillation equipment is used to purify recovered liquid Freon for reuse. However, military specifications require that most processes use only ultrapure solvent, so only Freon that is not significantly contaminated may be recycled. The remainder is sold to an offsite waste handling facility.

C. SCOPE/APPROACH

This project was conducted in two steps. Step one involved a source identification study and a Freon emissions survey. Such engineering parameters as temperature, pressure, flow

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rates, and Freon concentrations were measured. This information was required to accurately determine the Freon emissions profile of Newark AFB, as well as to facilitate the identification of various emission reduction strategies. Step two of this project consisted of reducing the data collected in step one, and developing and evaluating a number of Freon emission control strategies.

SECTION II
TEST AND SITE DESCRIPTION

A description of the Newark AFB Building 4 facility and the test procedures followed is provided in this section.

A. SITE DESCRIPTION

The facility of interest at Newark AFB is Building 4, in which mechanical components and gyros for inertial guidance systems are cleaned and repaired. Only a few solvents are used in large quantities in the cleaning operations: Freon, 1,1,1-trichloroethane (TCA), propanol, toluene, and acetone. Of these, Freon is the most commonly used.

The Building 4 facility consists of a large, three-level building in which smaller buildings or rooms are housed. The cleaning and repair work is done on the first floor of the building. There are a large number of individual Freon emission point sources located on the first floor. The results of a previous study indicated that the most significant Freon emission sources are solvent spray booths, flush stations, vapor degreasers and ultrasonic cleaners.[1] Of these sources, the most significant are those in which the Freon vapor generated at each source is exhausted from the room through a hood and routed to either a CA vapor recovery system or to the outside. Ten exhaust ducts were identified for testing; each duct was numbered and identified as a test site.

Two CA systems are in place in Building 4 at Newark AFB. Ostensibly, these systems recover solvent vapors present in the exhaust streams. For a variety of reasons, the recovery efficiencies of these systems have been marginal at best; thus, the characterization of their operation and duty cycles was an integral part of the test. The exhaust ducts from a total of 23 Freon point sources are connected to the CA systems.

More than 10 significant Freon emission point sources are vented directly to the air. The exhaust ducts of some of these sources are connected; thus, a total of eight exhaust ducts are vented directly outside.

A schematic diagram provided in Figure 1 indicates the sources tested that are vented directly to the outside. In addition, sources vented to the CA systems are indicated.

B. TEST DESCRIPTION

Three principal measurements were performed during this test series. The first was a measurement of air flow rates through exhaust ducts. The second measurement was the linear flow rate at the front faces and access ports of process booths connected to the CA systems. The third measurement was to determine Freon concentration variations in the duct over an extended period of time. At two of the test sites (CA 3 and CA 4), an additional measurement was performed to determine TCA concentration variations. TCA is occasionally used in the

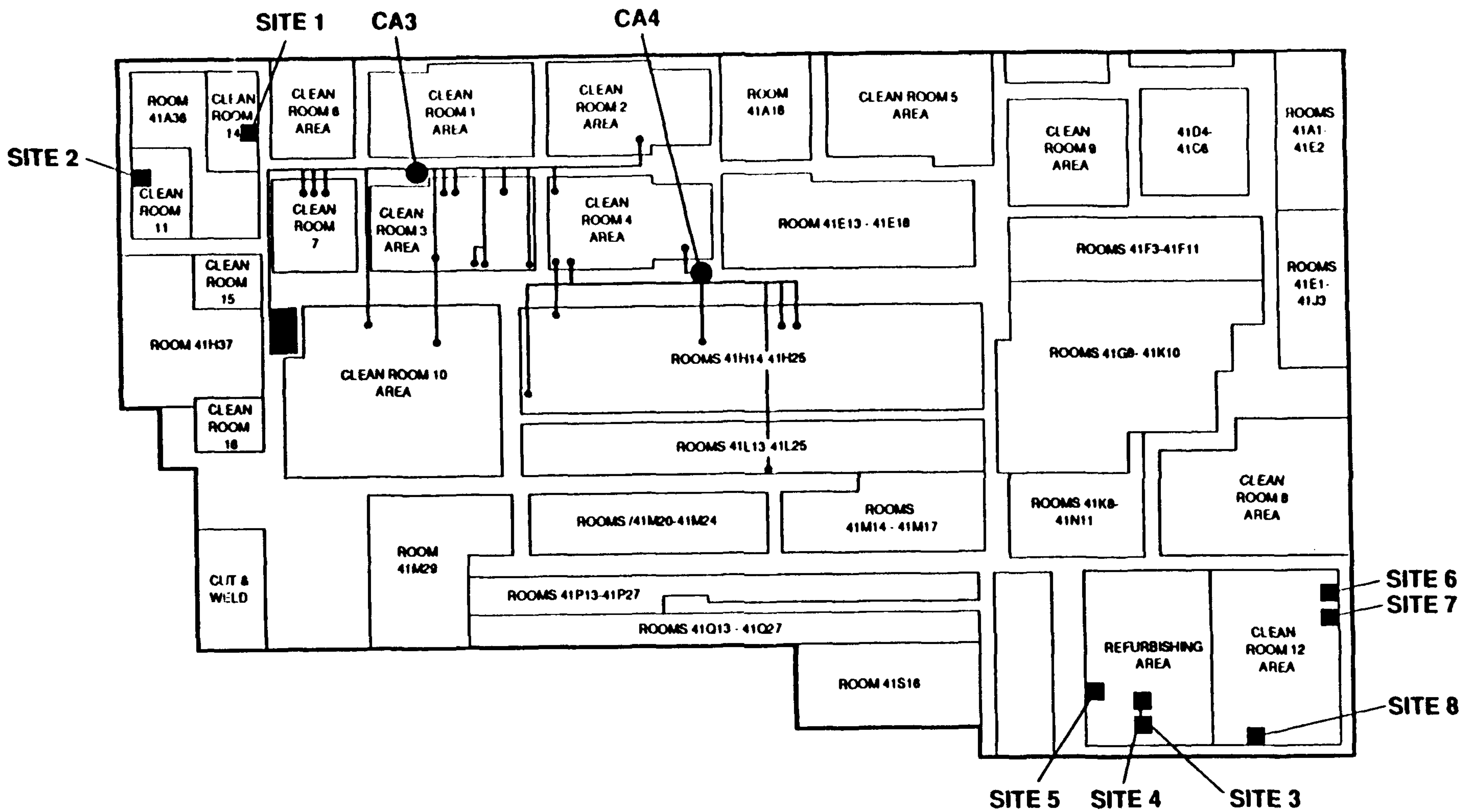

Figure 1. Newark Air Force Base Building 4 - First Floor Plan Including Sample Sites and Sources Connected to CA 3 and CA 4.

process booths connected to the carbon adsorption systems. Each of these measurements is discussed below.

1. Air Flow Measurements in Ducts

Air volume flow measurements were taken in the duct to determine emission rates. The air flow rate was measured using a pitot tube according to EPA Method 2 procedures.

2. Air Flow Measurements at Booth Faces

Linear air flow rate measurements were taken at booth faces and access ports of process booths connected to the CA systems. These measurements were performed with an anemometer according to ACGIH procedures.

3. Continuous Freon Concentration Measurements

The Freon concentration in the duct was monitored continuously using a Gastech Model 3290 Freon Analyzer, which operates in a manner similar to an infrared spectrophotometer. The detector is set to 9.1 μm, a wavelength at which Freon absorbs strongly. A review of infrared spectral data indicated that there is little or no interference from such background gases as O_2, CO_2 and N_2.

Calibration of the Freon analyzer was performed at 12-hour intervals with the use of zero, span, and calibration gases. The zero gas was pure nitrogen (which causes zero response on the instrument), and the span and calibration gases were composed of Freon in nitrogen at 4046 and 1060 ppm, respectively. These gases were selected based on anticipated concentrations; a target of 4000 ppm was selected for the span gas because it was anticipated that actual Freon concentrations would be much less, and 1000 ppm was targeted for the calibration gas because it was estimated that actual Freon concentration would be approximately 1000 ppm.

A strip chart recorder was operated in tandem with the Freon analyzer to record the concentration variations throughout the test. The strip chart data were later reduced to determine emission rates and time-dependent concentration variations.

4. 1,1,1-Trichlorethane Concentration Measurements

The measurement of TCA concentrations at the inlet ducts to both CA systems was performed using a variable-wavelength infrared spectrophotometer. This measurement was taken simultaneously with Freon concentration measurements described above. The measurement of TCA concentrations was motivated by the fact that TCA has an absorption edge at 8.9 μm, which is very close to the wavelength at which the Freon analyzer operates (2). Due to this wavelength overlap, it was believed that the presence of TCA in the duct would result in a misleading measurement, because it would be mistakenly measured as Freon by the Freon analyzer.

The spectrophotometer detector was set to measure absorbance at 14 μm, a wavelength at which neither Freon, CO_2, O_2, nor water vapor absorbs (2). In this way, TCA

concentrations in the duct were measured separately, and the contribution made by the TCA to Freon analyzer measurement results could be removed.

SECTION III
TEST RESULTS

The results of the test efforts at Newark AFB are presented here in two subsections; the first subsection discusses the results of the continuous Freon concentration monitoring efforts, and the second presents results of air flow rate measurements taken at the test sites and at the various point sources connected to CA 3 and CA 4.

A. CONTINUOUS FREON CONCENTRATION MEASUREMENTS

Ten exhaust ducts carrying solvent vapors from process booths and work stations were monitored to determine the quantity of Freon vapor vented. Eight of these ducts are currently vented directly to the outside of Building 4. Each of the remaining two ducts is vented to CA systems that are used to recover solvent vapors present in the process stream. The ducts vented directly to the outside generally draw exhaust from only one source, whereas the ducts vented to CA systems draw exhaust from multiple sources.

1. Site 1 -- Peacekeeper Area

The exhaust duct denoted as Site 1 is situated next to Room 41B35 in the Peacekeeper area. It is one of eight exhaust ducts through which Freon is emitted to the outside air. Because the work taking place in the Peacekeeper area is classified, security clearance is required to gain access to the work rooms. The field crew was not given sufficiently high clearance to allow access, so it was not possible to determine the number of Freon emission point sources that contribute to the Site 1 duct emissions. The results of an earlier inventory study indicate that significant Freon losses occur in this area, thus it was anticipated that high Freon concentrations would be measured in the Site 1 exhaust duct.

All of the Freon emission sources connected to the Site 1 duct are "footpad-activated"; i.e. the exhaust fan for each point source operates only when someone is standing at the work station and is presumably using Freon. To remove residual solvent vapors, the fan remains on a short while after the worker has left the vicinity of the station. While the fan is not on, a small background concentration of Freon may often be detected. This is due to Freon vapors diffusing up from the work station into the exhaust duct. This residual Freon should not be considered as contributing to the total emissions, because no flow exists through the duct to carry the vapors outside.

At this type of source, Freon is actually emitted only when the exhaust fan is operating. Thus, the Freon analyzer at this site measured a series of peak concentrations (which indicate that the workstation is in use and Freon is being exhausted), followed by a low-concentration plateau (which indicates that the exhaust fan is not on, and Freon is not being emitted). When

the chart recorder data were reduced, only the concentrations measured under the peaks were included in the total Freon emission calculation. The low-concentration plateau measurements were not considered to be contributing to the overall emissions.

Continuous Freon concentration measurements at Site 1 occurred over a 38-hour period. Testing was initiated at 1000 on 13 September 1988, and ended at 2400 on 15 September, 1988. The results of this test, given in Table 1, are presented in prescribed time intervals (indicated in column one of Table 1). Time intervals that appear to be omitted from column one (such as between 2300 and 2400 on 13 September) indicate periods during which instrument calibration and paper replacement occurred. The length of sample time in each interval is given in column two, and is summed at the bottom of the table. This value indicates actual sampling time; time spent in instrument calibration is not erroneously included as sampling time. The number of events, or peaks, occurring in each time interval is given in column three. The Freon measured under each of these peaks is summed to determine actual Freon emission rates. As described in an earlier paragraph, low-concentration plateaus are not included in this calculation.

Column four of Table 1 indicates the total area measured under each peak in units of ppm-minutes. The conversion factor used to convert from square inches measured on the strip chart to ppm-min has already been applied and corrected for system drift (see Section VII). The event lifespan (length of time the fan was on for each event) is given in column five. With this parameter, an average concentration for each event can be calculated, and the result is reported in columns six and seven as ppm and g/L, respectively. When the average air flow rate result is applied to the average Freon concentration given in column seven, the total quantity of Freon emitted during the event lifespan may be derived. This value is given in column eight. The quantity of Freon emitted in each time interval is summed at the bottom of column eight to indicate the total quantity of Freon emitted from the Site 1 exhaust duct throughout the entire test.

2. Site 2 -- Peacekeeper Area

The exhaust duct denoted as Site 2 is situated next to Clean Room 11 (Rm 41E37) in the Peacekeeper area. It is also one of eight exhaust ducts through which Freon is emitted to the outside air. Because the Site 2 duct is located in the Peacekeeper area, it was not possible for the field crew to determine the number of contributing Freon emission point sources. The results of an earlier inventory study indicate that significant Freon losses occur in this area; thus, it was anticipated that high Freon concentrations would be detected at this site.

As with the Site 1 exhaust duct, all of the Freon emission sources connected to the Site 2 duct are "footpad-activated"; thus, while the fan is not on, a small background concentration of Freon may often be detected. For this reason, when the chart recorder data were reduced, only the concentrations measured under the peaks were included in the total

TABLE 1. CONTINUOUS FREON CONCENTRATION MEASUREMENTS AT SITE 1.

SITE 1 -- PEACEKEEPER
TEST BEGIN: 13 September 1000
TEST END: 15 September 2400

TIME & DATE	DURATION TIME (minutes)	EVENT NUMBER	SUM OF EVENT AREAS (ppm-mins)	EVENT LIFESPAN (minutes)	AVERAGE CONCENTRATION FOR EVENT (ppm)	QUANTITY EMITTED (kgs	lbs)
13 Sept							
1000-1100	60	1	3808	5.2	732	0.67	1.5
		2	1364	4.8	284	0.24	0.5
		3	1535	4.4	349	0.27	0.6
1100-1200	60	0					
1200-1300	60	1	4547	9.2	494	0.81	1.8
1300-1400	60	0					
1400-1500	60	1	1933	2.8	690	0.34	0.8
1500-1600	60	1	2387	5.2	459	0.42	0.9
		2	4320	12	348	0.77	1.7
1600-1700	60	1	5002	10	500	0.89	1.9
		2	21486	18	1194	3.8	8.4
1700-1800	60	1	4718	4.8	983	0.84	1.8
		2	3240	5.2	623	0.57	1.3
1800-1900	60	1	6992	8	874	1.2	2.7
		2	5002	4.4	1137	0.89	1.9
		3	5002	8.8	568	0.89	1.9
1900-2000	60	0					
2000-2100	60	1	6196	6.8	911	1.1	2.4
2100-2300	120	0					
14 Sept							
2400-0100	60	1	3533	7.6	465	0.63	1.4
		2	12339	14	857	2.2	4.8
0100-0200	60	1	449	1.6	280	0.08	0.2
0200-0400	120	0					
0400-0500	60	1	3533	7.6	465	0.63	1.4
		2	2916	6	486	0.52	1.1
0500-0600	60	0					
0600-0700	60	1	2804	3.6	779	0.50	1.1
		2	2019	4	505	0.36	0.8
		3	1514	4.4	344	0.27	0.6

TABLE 1. CONTINUOUS FREON CONCENTRATION MEASUREMENTS AT SITE 1 (CONCLUDED).

SITE 1 -- PEACEKEEPER
TEST BEGIN: 13 September 1000
TEST END: 15 September 2400

TIME & DATE	DURATION TIME (minutes)	EVENT NUMBER	SUM OF EVENT AREAS (ppm-mins)	EVENT LIFESPAN (minutes)	AVERAGE CONCENTRATION FOR EVENT (ppm)	QUANTITY EMITTED (kgs	lbs)
0700-0800	60	1	2692	4.4	612	0.48	1.0
		2	1402	3.6	389	0.25	0.5
		3	4206	6	701	0.75	1.6
0800-0900	60	1	2075	4	519	0.37	0.8
		2	1458	2.8	521	0.26	0.6
		3	2075	4	519	0.37	0.8
0900-1000	60	0					
1000-1100	60	1	7627	8	953	1.4	3.0
		2	729	4	182	0.13	0.3
		3	1346	3.6	374	0.24	0.5
1100-1200	60	1	3253	6.4	508	0.58	1.3
1300-1400	60	1	2847	5.6	508	0.50	1.1
1400-1500	60	0					
1500-1600	60	1	5171	10	517	0.92	2.0
		2	3486	6.8	513	0.62	1.4
1600-1700	60	1	465	1.6	291	0.08	0.2
		2	1685	4.4	383	0.30	0.7
		3	1162	5.6	208	0.21	0.5
1700-1800	60	1	4648	11	415	0.82	1.8
		2	1046	2.8	374	0.19	0.4
1800-1900	60	1	872	3.6	242	0.15	0.3
		2	697	2.4	291	0.12	0.3
1900-2000	60	1	523	1.2	436	0.09	0.2
2000-2100	60	1	7786	7.2	1081	1.4	3.0
2100-2200	60	1	5520	5.2	1062	0.98	2.2
2200-2300	60	1	2440	5.2	469	0.43	1.0
2300-2400	60	1	3603	9.2	392	0.64	1.4
		2	4009	13	304	0.71	1.6
Total:	2160 minutes					32 kg	70 pounds

Freon emission calculation. The low-concentration plateau measurements were not considered to contribute to the overall emissions.

Continuous Freon concentration measurements at Site 2 occurred over a 38.5-hour period. Testing was initiated at 1045 on 13 September 1988 and ended at 0120 on 16 September 1988. The results of this test are presented in Table 2. The organization of Table 2 is the same as that of Table 1.

3. Site 3 -- Refurbishing Area

The exhaust duct denoted as Site 3 is situated adjacent to Room 41S6 in the refurbishing area. This duct draws exhaust air from a solvent flushing booth located in Room 41S6 and vents it to the outside. This work station is considered a significant emission source in this work area, which is operated one shift per day. For this reason, no solvent emissions were detected after 1600. The Freon emission source connected to the Site 3 duct is "footpad-activated" and the data reduction techniques used on the Site 1 and 2 test results were applied to the Site 3 results.

Continuous Freon concentration measurements at Site 3 occurred over a 33-hour period. Testing was initiated at 1045 on 13 September 1988. Due to an electronic malfunction of the Freon analyzer, the test was stopped temporarily at 0900 on 14 September. Testing was resumed at 1542 and ended at 0300 on 15 September 1988. The results of this test are presented in Table 3. The organization of Table 3 is the same as Table 1. Table 3 includes two short time lapses during which data were not taken. This was due to a problem with the paper feed mechanism on the chart recorder. This problem was corrected as soon as it was detected.

4. Site 4 -- Refurbishing Area

The exhaust duct denoted as Site 4 is situated next to Room 41S6 in the refurbishing area. This duct draws exhaust air from a solvent spray booth located in Room 41S6 and vents it to the outside. This work station is considered a significant emission source in this work area. Because it is a single-shift operation, no solvent emissions were detected after 1600. The Freon emission source connected to the Site 4 duct is "footpad-activated." Data reduction techniques used on previously presented test results were applied to the Site 4 results. Continuous Freon concentration measurements at Site 4 occurred over a 29-hour period. Testing was initiated at 1045 on 13 September 1988 and was terminated at 1542 on 14 September. In the original test plan, emissions testing at this site was to continue until the morning of 15 September. However, due to a malfunction of the Freon analyzer used at Site 3, the analyzer used at Site 4 (which was operating properly) was switched to Site 3 after approximately 29 hours. In this way, accurate data were collected at each site during an entire work cycle. The alternative would have been to replace the malfunctioning Freon analyzer with another analyzer, which would have required system calibration before operation. Because activity in this work area ceases before 1700, there would not have been sufficient time to get the new analyzer functioning before the shift

TABLE 2. CONTINUOUS FREON CONCENTRATION MEASUREMENTS AT SITE 2.

SITE 2 -- PEACEKEEPER
TEST BEGIN: 13 September 1045
TEST END: 15 September 0120

TIME & DATE	DURATION TIME (minutes)	EVENT NUMBER	SUM OF EVENT AREAS (ppm-mins)	EVENT LIFESPAN (minutes)	AVERAGE CONCENTRATION FOR EVENT (ppm)	QUANTITY EMITTED (kgs	lbs)
13 Sept							
1045-1100	15	1	1814	2	907	0.49	1.1
		2	767	2.4	320	0.20	0.5
1100-1200	60	0					
1200-1300	60	1	837	1.6	523	0.22	0.5
		2	4883	3.2	1526	1.3	2.9
		3	977	3.2	305	0.26	0.6
		4	488	1.6	305	0.13	0.3
1300-1400	60	1	698	2	349	0.18	0.4
1400-1500	60	1	698	0.8	872	0.18	0.4
		2	488	1.2	407	0.13	0.3
		3	558	0.8	698	0.15	0.3
		4	977	1.6	610	0.26	0.6
		5	1046	1.2	872	0.28	0.6
1500-1600	60	1	349	0.5	698	0.09	0.2
1600-1700	60	multiple	5302	21	255	1.4	3.2
		2	698	1.2	581	0.18	0.4
		3	3976	4.8	828	1.1	2.4
1700-1800	60	1	1046	1.2	872	0.28	0.6
		2	1395	1.6	872	0.37	0.8
		3	837	0.6	1395	0.22	0.5
1800-1900	60	1	558	0.4	1395	0.15	0.3
1900-2000	60	1	3558	0.6	5930	0.96	2.1
2000-2100	60	0					
2100-2200	60	1	279	0.4	698	0.07	0.2
2200-2300	60	0					
2300-2400	60	1	558	0.6	930	0.15	0.3
		2	628	0.6	1046	0.17	0.4

TABLE 2. CONTINUOUS FREON CONCENTRATION MEASUREMENTS AT SITE 2 (CONTINUED).

SITE 2 -- PEACEKEEPER
TEST BEGIN: 13 September 1045
TEST END: 15 September 0120

TIME & DATE	DURATION TIME (minutes)	EVENT NUMBER	SUM OF EVENT AREAS (ppm-mins)	EVENT LIFESPAN (minutes)	AVERAGE CONCENTRATION FOR EVENT (ppm)	QUANTITY EMITTED (kgs	lbs)
14 Sept							
0100-0500	240	0					
0500-0600	60	1	19928	54	369	5.4	12
0600-0654	54	0					
0654-0800	66	1	10340	34	304	2.8	6.2
		2	3835	21	181	1.0	2.3
		3	12806	6	2134	3.5	7.7
		4	14038	6	2340	3.8	8.4
0800-0904	64	1	15545	16	972	4.2	9.3
		2	3424	12	285	0.93	2.0
		3	2465	4.8	514	0.66	1.5
		4	3698	7.2	514	1.0	2.2
		5	6780	11	605	1.8	4.1
		6	4520	13	342	1.2	2.7
0904-0957	53	multiple	8286	17	471	2.3	5.0
0957-1100	63	1	3082	6.8	453	0.83	1.8
		2	6300	12	525	1.7	3.8
		3	2123	11	190	0.57	1.3
		4	3698	7.2	514	1.0	2.2
		5	4999	8	625	1.4	3.0
1214-1400	106	1	868	5.2	167	0.23	0.5
		2	1389	7.2	193	0.37	0.8
		3	8100	17	471	2.2	4.8
		multiple	62716	49	1275	17	38
1400-1500	60	multiple	33267	36	924	9.0	20
		2	3124	8.8	355	0.84	1.9
		3	3066	4.8	639	0.83	1.8
1500-1600	60	multiple	15158	23	653	4.1	9.1
		2	2488	7.2	346	0.67	1.5
		multiple	7984	21	384	2.2	4.8

TABLE 2. CONTINUOUS FREON CONCENTRATION MEASUREMENTS AT SITE 2 (CONCLUDED).

SITE 2 -- PEACEKEEPER
TEST BEGIN: 13 September 1045
TEST END: 15 September 0120

TIME & DATE	DURATION TIME (minutes)	EVENT NUMBER	SUM OF EVENT AREAS (ppm-mins)	EVENT LIFESPAN (minutes)	AVERAGE CONCENTRATION FOR EVENT (ppm)	QUANTITY EMITTED (kgs	lbs)
1600-1800	120	1	3240	7.2	450	0.88	1.9
		2	1678	4	419	0.45	1.0
		3	2719	5.6	486	0.73	1.6
		4	1736	4.4	394	0.47	1.0
		5	2025	4.8	422	0.55	1.2
		6	1794	4.8	374	0.48	1.1
		7	5786	10	579	1.6	3.5
		8	8216	12	685	2.2	4.9
		9	1562	4	391	0.42	0.9
		10	5091	6.8	749	1.4	3.0
		11	3761	6	627	1.0	2.2
1800-1906	66	1	2661	6.8	391	0.72	1.6
		2	579	2	289	0.15	0.3
		3	5207	6	868	1.4	3.1
		4	5554	11	496	1.5	3.3
1906-2000	54	1	694	4	174	0.18	0.4
		2	4860	11	434	1.3	2.9
2000-2043	43	0					
2043-2200	103	1	1736	7.2	241	0.47	1.0
		2	2199	9.6	229	0.59	1.3
		3	4571	6.8	672	1.2	2.7
		4	1331	4.8	277	0.36	0.8
		5	2835	6.8	417	0.77	1.7
2200-2300	60	1	810	1.2	675	0.22	0.5
		2	13075	20	654	3.6	7.8
2300-2356	56	1	3356	7.6	442	0.91	2.0
		2	6422	11	595	1.7	3.8
		3	3182	9.2	346	0.86	1.9
15 Sept							
2356-0100	64	1	1389	4	347	0.37	0.8
		2	1389	2	694	0.37	0.8
		3	9431	31	306	2.6	5.6
		4	1273	6.4	199	0.34	0.8
0100-0120	20	1	7290	5.2	1402	2.0	4.4
Total:	2207 minutes					113 kg	248 pounds

TABLE 3. CONTINUOUS FREON CONCENTRATION MEASUREMENTS AT SITE 3.

SITE 3 -- REFURBISHING AREA
TEST BEGIN: 13 September 1045
TEST END: 15 September 0300

TIME & DATE	DURATION TIME (minutes)	EVENT NUMBER	SUM OF EVENT AREAS (ppm-mins)	EVENT LIFESPAN (minutes)	AVERAGE CONCENTRATION FOR EVENT (ppm)	QUANTITY EMITTED (kgs	lbs)
13 Sept							
1045-1100	15	1	9178	11	834	0.83	1.8
1100-1145	45	1	23919	43	556	2.2	4.8
Paper jam							
1315-1400	45	1	14185	11	1290	1.3	2.8
1400-1420	20	1	8344	9.3	897	0.75	1.7
1432-1500	28	1	33932	28	1212	3.1	6.7
1500-1600	60	1	47560	55	865	4.3	9.4
1600-2140	340	0	0	0			
2230-2400	90	0	0	0			
14 Sept							
2400-0240	160	0	0	0			
Paper jam							
0320-0900	340	0	0	0			
Changed Probe							
1542-1600	18	1	8299	13	638	0.75	1.6
1600-2400	480	0	0	0			
15 Sept							
2400-0300	180	0		0			
Total:	1821 minutes					13 kg	29 pounds

ended. Thus, the most expedient solution was to switch the analyzer from Site 4 to Site 3, thereby forgoing approximately 1.5 hours of monitoring at Site 4 during the working shift. The results of this test are presented in Table 4. The organization of Table 4 is the same as Table 1.

5. Site 5 -- Refurbishing Area

The exhaust duct denoted as Site 5 is situated next to Room 41S6 in the refurbishing area. This duct draws exhaust air from three individual sources located in Rooms 41R9 and 41R9A and is vented to the outside. Only one source, a Freon spray booth, is considered significant. No cleaning or maintenance operations appear to occur at the other two sources (one is a solvent drain hood, the other is a work bench area). This area generally supports one shift per day; thus no solvent emissions were detected after 1600. The Freon emission source connected to the Site 5 duct is "footpad-activated"; thus the data reduction techniques used on the previously presented results were applied on the Site 5 results.

Continuous Freon concentration measurements at Site 5 occurred over a 45-hour period. Testing was initiated at 0424 on 15 September 1988 and was terminated at 0100 on 17 September. The results of this test are presented in Table 5.

6. Sites 6, 7, and 8 -- Clean Room 12

The exhaust ducts denoted as Sites 6,7, and 8 are situated next to Room 41S3 in the Clean Room 12 area. These ducts appear to draw exhaust from at least three individual sources located in Room 41S3, and they are vented to the outside. This area operates two shifts per day; thus, the test was ended at the end of the second shift on the second day. Most of the Freon emission sources connected to these ducts are "footpad-activated"; thus, the data reduction techniques used on the previously presented results were applied in these cases as well.

Continuous Freon concentration measurements at Site 6 occurred over a 42-hour period. Testing was initiated at 0700 on 15 September 1988 and was terminated at 0100 on 17 September. The results of this test are presented in Table 6.

Continuous Freon concentration measurements at Site 7 occurred over a 41-hour period. Testing was initiated at 0700 on 15 September 1988 and was terminated at 0100 on 17 September. The results of this test are presented in Table 7.

Continuous Freon concentration measurements at Site 8 occurred over a 42.5-hour period. Testing was initiated at 0700 on 15 September and was terminated at 0120 on 17 September. The results of this test are presented in Table 8.

7. Carbon Adsorption Bed 3

There are at least 14 individual solvent spray booths, flush booths, and workstations that are vented to CA 3, as well as numerous process tanks and holding tanks used in the distillation system. All of the contributing sources are used quite heavily from one to three shifts per day. During an initial site visit by Acurex and EPA personnel in February 1988, it was learned

TABLE 4. CONTINUOUS FREON CONCENTRATION MEASUREMENTS AT SITE 4.

SITE 4 -- REFURBISHING AREA
TEST BEGIN: 13 September 1045
TEST END: 14 September 1542

TIME & DATE	DURATION TIME (minutes)	EVENT NUMBER	SUM OF EVENT AREAS (ppm-mins)	EVENT LIFESPAN (minutes)	AVERAGE CONCENTRATION FOR EVENT (ppm)	QUANTITY EMITTED (kgs	lbs)
13 Sept							
1045-1145	60	1	102	1.9	54	0.01	0.02
		2	102	3.8	27	0.01	0.02
Paper jam							
1315-1400	45	0					
1400-1500	60	1	3366	5.3	641	0.34	0.74
		2	1326	3	442	0.13	0.29
1500-1600	60	0					
1600-1700	60	1	204	2.6	78	0.02	0.04
1700-2200	300	0					
2244-2400	76	0					
14 Sept							
2400-0240	160	0					
Paper jam							
0320-0700	220	0					
0700-0800	60	1	1575	8.6	183	0.16	0.35
0800-0900	60	0					
0900-1000	60	1	3255	4.1	794	0.33	0.72
		2	525	2.6	202	0.05	0.12
1000-1100	60	0					
1100-1200	60	1	1470	1.9	774	0.15	0.32
1200-1300	60	1	525	1.7	309	0.05	0.12
		2	525	3.4	154	0.05	0.12
1300-1400	60	1	1877	3.7	507	0.19	0.41
1400-1434	34	1	442	1.1	401	0.04	0.10
1500-1542	42	1	1766	2.6	679	0.18	0.39
		2	552	2.6	212	0.06	0.12
Total:	1563 minutes					1.8 kg	3.9 pounds

SWITCHED PROBE OVER TO SITE 3

TABLE 5. CONTINUOUS FREON CONCENTRATION MEASUREMENTS AT SITE 5.

SITE 5 -- REFURBISHING AREA
TEST BEGIN: 15 September 0424
TEST END: 17 September 0100

TIME & DATE	DURATION TIME (minutes)	EVENT NUMBER	SUM OF EVENT AREAS (ppm-mins)	EVENT LIFESPAN (minutes)	AVERAGE CONCENTRATION FOR EVENT (ppm)	QUANTITY EMITTED (kgs	lbs)
15 Sept							
0424-1225	481	0					
1225-1325	60	1	1938	3.4	570	0.54	1.2
		2	570	3	190	0.16	0.4
1325-2030	425	0					
16 Sept							
2100-0600	540	0					
0600-0700	30	1	2636	8.3	319	0.74	1.6
0700-0900	120	0					
17 Sept							
1000-0100	900	0					
Total:	2556 minutes					1.4 kg	3.2 pounds

TABLE 6. CONTINUOUS FREON CONCENTRATION MEASUREMENTS AT SITE 6.

SITE 6 -- CLEAN ROOM 12
TEST BEGIN: 15 September 0700
TEST END: 17 September 0100

TIME & DATE	DURATION TIME (minutes)	EVENT NUMBER	SUM OF EVENT AREAS (ppm-mins)	EVENT LIFESPAN (minutes)	AVERAGE CONCENTRATION FOR EVENT (ppm)	QUANTITY EMITTED (kgs	lbs)
15 Sept							
0700-0800	60	1	5946	13	450	0.22	0.49
		2	6566	5.6	1173	0.25	0.54
		3	2590	8	324	0.10	0.21
		4	2225	3.2	695	0.08	0.18
		5	2663	2.6	1024	0.10	0.22
0800-0900	60	1	8682	14	620	0.32	0.71
		2	3648	10	365	0.14	0.30
		3	2152	6.4	336	0.08	0.18
		4	2432	4.8	507	0.09	0.20
		5	1933	4	483	0.07	0.16
		6	2462	4.8	513	0.09	0.20
0900-1000	60	1	876	2.4	365	0.03	0.07
		2	1952	4.4	444	0.07	0.16
		3	2079	3.2	650	0.08	0.17
		4	2079	3.2	650	0.08	0.17
		5	2286	5.6	408	0.09	0.19
1000-1100	60	1	7770	14	555	0.29	0.64
		2	4013	12	324	0.15	0.33
		3	2627	9.2	285	0.10	0.22
1100-1200	60	1	1167	1.6	730	0.04	0.10
		2	2152	5.2	414	0.08	0.18
		3	1800	6	300	0.07	0.15
		4	3174	11	283	0.12	0.26
		5	3210	12	277	0.12	0.26
1200-1300	60	1	4907	5.2	944	0.18	0.40
		2	3210	12	277	0.12	0.26
1300-1400	60	1	2298	7	328	0.09	0.19
		2	2554	12	220	0.10	0.21
		3	8700	6.8	1279	0.33	0.72
		4	7041	11	652	0.26	0.58
		5	2189	2.8	782	0.08	0.18
		6	2772	7.2	385	0.10	0.23
		7	5399	21	260	0.20	0.44
1400-1500	60	1	2503	11	223	0.09	0.21
		2	4086	4	1021	0.15	0.34

TABLE 6. CONTINUOUS FREON CONCENTRATION MEASUREMENTS AT SITE 6 (CONTINUED).

SITE 6 -- CLEAN ROOM 12
TEST BEGIN: 15 September 0700
TEST END: 17 September 0100

TIME & DATE	DURATION TIME (minutes)	EVENT NUMBER	SUM OF EVENT AREAS (ppm-mins)	EVENT LIFESPAN (minutes)	AVERAGE CONCENTRATION FOR EVENT (ppm)	QUANTITY EMITTED (kgs	lbs)
1500-1600	60	1	6105	10	610	0.23	0.50
		2	2238	6.4	350	0.08	0.18
		3	1994	5.6	356	0.07	0.16
		4	2092	4	523	0.08	0.17
		5	3380	5.2	650	0.13	0.28
		6	5727	13	447	0.21	0.47
		7	3794	6	632	0.14	0.31
		8	5837	28	206	0.22	0.48
1600-1900	180	0					
1900-2008	68	1	1751	13	137	0.07	0.14
2052-2100	8	0					
2100-2200	60	0					
2200-2300	60	1	7589	17	441	0.28	0.62
2300-2400	60	0					
16 Sept							
2400-0100	60	1	7047	16	430	0.26	0.58
0100-0656	356	0					
0658-0800	62	1	4724	12	381	0.18	0.39
		2	774	2	387	0.03	0.06
		3	4956	16	310	0.19	0.41
0800-0900	60	multiple	38875	47	824	1.5	3.2
0900-1000	60	multiple	14404	26	554	0.54	1.2
1000-1100	60	1	5343	6	891	0.20	0.44
1100-1200	60	1	3175	6.8	467	0.12	0.26
		2	3717	8	465	0.14	0.31
		3	5498	6	916	0.21	0.45
		4	5963	16	373	0.22	0.49
		5	2710	6	452	0.10	0.22
		6	3872	6	645	0.14	0.32
		7	5266	16	329	0.20	0.43

TABLE 6. CONTINUOUS FREON CONCENTRATION MEASUREMENTS AT SITE 6 (CONCLUDED).

SITE 6 -- CLEAN ROOM 12
TEST BEGIN: 15 September 0700
TEST END: 17 September 0100

TIME & DATE	DURATION TIME (minutes)	EVENT NUMBER	SUM OF EVENT AREAS (ppm-mins)	EVENT LIFESPAN (minutes)	AVERAGE CONCENTRATION FOR EVENT (ppm)	QUANTITY EMITTED (kgs	lbs)
1200-1249	49	0					
1249-1400	71	1	4027	4.4	915	0.15	0.33
		2	6582	5.2	1266	0.25	0.54
		3	7124	8	891	0.27	0.59
		4	5034	7.2	699	0.19	0.41
		5	6660	7.2	925	0.25	0.55
		6	14326	24	597	0.54	1.18
		7	1084	12	90	0.04	0.09
1400-1413	13	1	7139	8.8	811	0.27	0.59
1434-1600	86	1	6490	5.6	1159	0.24	0.53
		2	4218	4	1055	0.16	0.35
		3	6381	7.6	840	0.24	0.52
		4	11573	16	742	0.43	0.95
		5	16008	23	690	0.60	1.32
		6	18604	18	1034	0.70	1.53
1600-1700	60	0					
1700-1800	60	1	1947	1.6	1217	0.07	0.16
1800-2100	180	0					
2100-2200	60	1	10059	18	559	0.38	0.83
2200-2300	60	0					
2300-2400	60	1	10059	17	585	0.38	0.83
17 Sept							
2400-0100	60	1	11249	18	611	0.42	0.93
Total:	2453 minutes					16 kg	34 pounds

TABLE 7. CONTINUOUS FREON CONCENTRATION MEASUREMENTS AT SITE 7.

SITE 7 -- CLEAN ROOM 12
TEST BEGIN: 15 September 0600
TEST END: 16 September 2300

TIME & DATE	DURATION TIME (minutes)	EVENT NUMBER	SUM OF EVENT AREAS (ppm-mins)	EVENT LIFESPAN (minutes)	AVERAGE CONCENTRATION FOR EVENT (ppm)	QUANTITY EMITTED (kgs	lbs)
15 Sept							
0604-0800	116	0					
0800-1000	120	1	27042	34	2080	3.6	7.9
		2	39835	27	3064	4.2	9.3
1000-1100	60	1	4729	8.5	364	0.2	0.34
1100-1200	60	1	5578	10	429	0.2	0.48
1200-1300	60	1	7033	4	541	0.1	0.24
		2	2243	1.5	173	0.0	0.03
1300-1400	60	1	13824	9	1063	0.5	1.1
1400-1500	60	0					
1500-1600	60	1	2001	1.5	154	0.01	0.03
		2	4608	1	354	0.02	0.04
1600-1900	60	0					
1940-2132	112	1	17265	13	1328	0.9	1.9
		2	29763	16	2289	1.9	4.1
2200-2400	60	0					
16 Sept							
2400-1056	656	0					
1116-1300	104	0					
1300-1400	60	1	9275	11	713	0.4	0.83
1400-1444	44	0					
1444-1700	134	1	106463	13	8189	5.2	12
1700-2300	360	0					
Total:	2186 minutes					17 kg	37 pounds

TABLE 8. CONTINUOUS FREON CONCENTRATION MEASUREMENTS AT SITE 8.

SITE 8 -- CLEAN ROOM 12
BEGIN: 15 September 0700
END: 17 September 0120

TIME & DATE	DURATION TIME (minutes)	EVENT NUMBER	SUM OF EVENT AREAS (ppm-mins)	EVENT LIFESPAN (minutes)	AVERAGE CONCENTRATION FOR EVENT (ppm)	QUANTITY EMITTED (kgs	lbs)
15 Sept							
0700-0800	60	1	21517	6	3586	6.5	14
0800-0900	60	1	49669	19	2614	15	33
0900-0959	59	multiple	72731	59	1233	22	48
0959-1100	61	multiple	49991	61	820	15	33
1100-1200	60	1	1933	6	322	0.6	1.3
1200-1300	60	1	5540	15	369	1.7	3.7
		2	2577	7	368	0.8	1.7
1300-1400	60	1	16105	18	895	4.9	11
1400-1500	60	1	5347	19	281	1.6	3.6
1500-1600	60	1	5540	15	369	1.7	3.7
1600-1700	60	0					
1700-1800	60	1	4832	15	322	1.5	3.2
1800-1848	48	0					
1920-2000	40	0					
2000-2200	120	1	23653	25	946	7.1	16
2200-2300	60	0					
2300-2400	60	1	4651	17	274	1.4	3.1

TABLE 8. CONTINUOUS FREON CONCENTRATION MEASUREMENTS AT SITE 8 (CONCLUDED).

SITE 8 -- CLEAN ROOM 12
BEGIN: 15 September 0700
END: 17 September 0120

TIME & DATE	DURATION TIME (minutes)	EVENT NUMBER	SUM OF EVENT AREAS (ppm-mins)	EVENT LIFESPAN (minutes)	AVERAGE CONCENTRATION FOR EVENT (ppm)	QUANTITY EMITTED (kgs	lbs)
16 Sept							
2400-0700	480	0					
0700-0800	60	multiple	20730	52	399	6.3	14
0800-0900	60	1	17142	26	659	5.2	11
		2	5515	11	501	1.7	3.7
0900-1000	60	1	1595	11	145	0.5	1.1
1000-1055	55	1	5515	21	263	1.7	3.7
1140-1200	20	0					
1200-1300	60	0					
1300-1400	60	1	4903	13	392	1.5	3.3
1400-1500	60	1	6089	18	338	1.8	4.0
1500-1600	60	0					
1600-1700	60	1	2372	7	339	0.7	1.6
1700-1800	60	1	1423	7	203	0.4	0.9
		2	2530	6	422	0.8	1.7
1800-1900	60	1	36532	21	1740	11	24
1900-2000	60	1	4744	13	365	1.4	3.2
17 Sept							
2000-0120	320	0					
Total:	2523 minutes					113 kg	248 pounds

that the CA unit was regenerated approximately once per year. The results of an inventory study performed in August 1988 indicated that the regeneration schedule should be stepped up to at least three times per week. A critical part of this test effort was to prove or disprove this contention and to evaluate process alternatives to improve CA system operation and solvent recovery efficiencies.

For the CA 3 test, which was conducted over a 56-hour period, influent and effluent Freon concentrations were measured, as well as influent TCA concentrations (as described in Section III). The test was started at 0938 on 13 September 1988 and ended at 1731 on 15 September 1988. Although the process booths exhausted to the CA bed are used intermittently, there is a continuously operated 10-hp fan located immediately upstream of the bed. Thus, there is a constant flow of air into the bed, unlike the sources tested at Sites 1 to 8, which are footpad activated.

The results of the CA 3 test are presented in Table 9. In this table, influent Freon concentrations (which measure the loading rate of the bed) are given. As stated previously, one of the primary objectives of this test series was to evaluate the operating efficiency of CA 3. A critical part of this evaluation was to determine how quickly breakthrough occurs after bed regeneration. For this reason, the bed was regenerated at 0900 on 14 September; thereafter, both the influent and effluent Freon concentrations were closely monitored. It was found that breakthrough occurred at approximately 1200 on 15 September. As expected, the Freon concentration measured in the CA 3 effluent duct did not rise significantly when breakthrough occurred. Rather, the strip chart recording indicates that the concentration rose just slightly above the baseline and leveled off somewhat. Shortly after, the concentration again rose slightly, to approximately 50 ppm.

The test was ended at 1531 on 15 September. TCA was detected in the CA 3 influent only once in the first 24 hours of operation. Approximately 200 ppm of TCA was detected for less than 5 minutes. Based on this result, it was determined that there is not enough TCA present in the CA 3 bed influent to affect the Freon concentration data.

During the calibration of the influent Freon monitor at 0232 on 14 September, the instrument began to drift. The monitor that was measuring concentrations in the effluent was relocated to read influent concentrations, while repair efforts were made on the drifting instrument. This was a reasonable course of action because, as discussed earlier, the effluent monitor was used only to determine whether or not breakthrough had occurred. Because breakthrough had indeed occurred the previous day, there was no reason to leave the monitor in the effluent duct.

At 0800 of the same day (14 September) it was determined that the monitor could not be repaired before the bed was regenerated at 0900. It was critical that the effluent concentration be constantly monitored after regeneration to determine breakthrough. Thus, the spectrophoto-

TABLE 9. CONTINUOUS FREON CONCENTRATION MEASUREMENTS AT CA 3.

CARBON ADSORPTION BED 3
BEGIN: 13 September 1000
END: 15 September 1731

TIME & DATE	DURATION TIME (minutes)	SUM OF EVENT AREAS (ppm-mins)	AVERAGE CONCENTRATION FOR EVENT (ppm)	QUANTITY INFLUENT[a] (kgs	lbs)
13 Sept					
1000-1100	60	5737	96	3.9	8.5
1100-1200	60	8640	144	5.8	13
1200-1300	60	13824	230	9.3	21
1300-1400	60	12856	214	8.7	19
1400-1500	60	1728	29	1.2	2.6
1500-1600	60	7430	124	5.0	11
1600-1700	60	588	10	0.4	0.9
1700-1800	60	4147	69	2.8	6.2
1800-1900	60	1175	20	0.8	1.7
1900-2000	60	3076	51	2.1	4.6
2000-2100	60	5426	90	3.7	8.1
2100-2200	60	6359	106	4.3	9.4
2200-2300	60	3007	50	2.0	4.5
2300-2400	60	1763	29	1.2	2.6
14 Sept					
2400-0100	60	4355	73	2.9	6.5
0100-0200	60	5564	93	3.8	8.3
0330-0400	30	5342	178	3.6	7.9
0400-0500	60	3662	61	2.5	5.4

[a] The effluent Freon concentrations from CA 3 were also monitored. However, because of the infrequent regeneration schedule, it may be assumed that the total quantity of Freon influent to CA 3 is the same as the quantity emitted, over the operation time scale. For this reason, only the influent quantity is reported in this table.

TABLE 9. CONTINUOUS FREON CONCENTRATION MEASUREMENTS AT CA 3 (CONTINUED).

CARBON ADSORPTION BED 3
BEGIN: 13 September 1000
END: 15 September 1731

TIME & DATE	DURATION TIME (minutes)	SUM OF EVENT AREAS (ppm-mins)	AVERAGE CONCENTRATION FOR EVENT (ppm)	QUANTITY INFLUENT[a] (kgs	lbs)
0500-0600	60	3293	55	2.2	4.9
0600-0700	60	8064	134	5.4	12
0700-0800	60	6317	105	4.3	9.4
0800-0900	60	8702	145	5.9	13
System Regeneration					
0900-1000	60	4469	74	3.0	6.6
1000-1100	60	15590	260	11	23
1100-1200	60	11088	185	7.5	16
1200-1300	60	11726	195	7.9	17
1345-1400	15	605	40	0.4	0.9
1400-1500	60	3494	58	2.4	5.2
1500-1600	60	7291	122	4.9	11
1600-1700	60	10114	169	6.8	15
1700-1800	60	17539	292	12	26
1800-1900	60	1512	25	1.0	2.2
1900-2000	60	706	12	0.5	1.0
2000-2100	60	1075	18	0.7	1.6
2100-2200	60	14314	239	9.7	21
2200-2300	60	4838	81	3.3	7.2
2300-2400	60	3528	59	2.4	5.2
2400-0030	30	3024	101	2.0	4.5

[a] The effluent Freon concentrations from CA 3 were also monitored. However, because of the infrequent regeneration schedule, it may be assumed that the total quantity of Freon influent to CA 3 is the same as the quantity emitted, over the operation time scale. For this reason, only the influent quantity is reported in this table.

TABLE 9. CONTINUOUS FREON CONCENTRATION MEASUREMENTS AT CA 3 (CONCLUDED).

CARBON ADSORPTION BED 3
BEGIN: 13 September 1000
END: 15 September 1731

TIME & DATE	DURATION TIME (minutes)	SUM OF EVENT AREAS (ppm-mins)	AVERAGE CONCENTRATION FOR EVENT (ppm)	QUANTITY INFLUENT[a] (kgs	lbs)
15 Sept					
0112-0200	48	11000	229	7.4	16
0200-0300	60	7148	119	4.8	11
0300-0400	60	14655	244	9.9	22
0400-0500	60	3395	57	2.3	5.0
0500-0600	60	228	4	0.2	0.3
0600-0700	60	4961	83	3.4	7.4
0700-0800	60	14525	242	9.8	22
0800-0900	60	3003	50	2.0	4.5
0900-1000	60	10510	175	7.1	16
1000-1100	60	8748	146	5.9	13
1100-1200	60	9270	154	6.3	14
System Breakthrough					
1200-1300	60	21640	361	15	32
1300-1400	60	7344	122	5.0	11
1400-1500	60	9564	159	6.5	14
1500-1600	60	35251	588	24	52
1600-1700	60	9466	158	6.4	14
TOTAL	3123 minutes			272 kg	598 pounds

[a] The effluent Freon concentrations from CA 3 were also monitored. However, because of the infrequent regeneration schedule, it may be assumed that the total quantity of Freon influent to CA 3 is the same as the quantity emitted, over the operation time scale. For this reason, only the influent quantity is reported in this table.

meter was reset to read the same wavelength as the Freon monitor (9μm), recalibrated with Freon, and placed in the CA 3 exhaust duct to measure effluent Freon concentrations. This was done because the spectrophotometer was no longer needed to measure TCA concentrations (as described previously, it was already established that little or no TCA was present in the CA 3 influent).

8. Carbon Adsorption Bed 4

There are at least nine individual solvent spray booths, flush booths, and workstations that are vented to CA 4. Some of the sources are used heavily for one to two shifts per day. Until recently, this CA unit was regenerated approximately once per year. The results of an inventory study performed at Newark AFB in July 1988 suggest that the regeneration schedule should be approximately twice per week. An important part of this test effort was to prove or disprove this contention. Unfortunately, due to a malfunctioning liquid solvent separator unit (which is used to remove the recovered solvent from the condensed steam), the CA 4 unit could not be regenerated the week of the test. The field crew was therefore not able to test throughout an entire regeneration cycle. For this reason, it was not critical to monitor the CA 4 effluent solvent concentration.

For the CA 4 test, which was conducted over a 28-hour period, influent Freon concentrations were measured, as well as influent TCA concentrations (as described in Section 3). The test was started at 1915 on 15 September 1988 and ended at 2253 on 16 September 1988. Because no third shift operates on Friday nights, there was no reason for continuing the test through the morning of 17 September.

The operating characteristics of CA 4 are very similar to those of CA 3, except that fewer sources are connected to CA 4, so the influent concentrations are much lower. As with CA 3, there is a continuously operated 10-hp fan located immediately upstream of the bed. Thus, there is a constant flow of air through the bed.

The results of the CA 4 test are presented in Table 10. In this table, influent Freon concentrations (which measure the loading rate of the bed) are given. As with the CA 3 results, no TCA was measured in the influent stream.

B. AIR FLOW RATE MEASUREMENTS

Two types of air flow rate measurements were performed in this test series. The first involved using EPA Method 2 for the measurement of flow rates in ducts. The second measurement required the use of an anemometer to determine flow rates at open faces. Each of these measurements is discussed separately in the following sections.

1. Air Flow Rate Measurements in Ducts

As described in Section II, air flow rate measurements were taken in all the ducts in which Freon concentrations were monitored. The results of these measurements are presented

TABLE 10. CONTINUOUS FREON CONCENTRATION MEASUREMENTS AT CA 4.

CARBON ADSORPTION BED 4
BEGIN: 15 September 1915
END: 16 September 2253

TIME & DATE	DURATION TIME (minutes)	SUM OF EVENT AREAS (ppm-mins)	AVERAGE CONCENTRATION FOR EVENT (ppm)	QUANTITY INFLUENT[a] (kgs	lbs)
15 Sept					
1915-2000	45	0	0	0	0
2000-2100	60	0	0	0	0
2100-2200	60	0	0	0	0
2200-2300	60	0	0	0	0
2300-2400	60	0	0	0	0
2400-0100	60	0	0	0	0
16 Sept					
0100-0200	60	0	0	0	0
0200-0300	60	0	0	0	0
0300-0400	60	0	0	0	0
0400-0500	60	0	0	0	0
0500-0600	60	0	0	0	0
0600-0700	60	0	0	0	0
0700-0800	60	3543	59	2.3	5.0
0800-0848	48	4012	84	2.6	5.6
0938-1000	22	0	0	0	0
1000-1100	60	8294	138	5.3	12

[a] The effluent Freon concentrations from CA 4 were also monitored. However, because of the infrequent regeneration schedule, it may be assumed that the total quantity of Freon influent to CA 4 is the same as the quantity emitted, over the operation time scale. For this reason, only the influent quantity is reported in this table.

TABLE 10. CONTINUOUS FREON CONCENTRATION MEASUREMENTS AT CA 4 (CONCLUDED).

CARBON ADSORPTION BED 4
BEGIN: 15 September 1915
END: 16 September 2253

TIME & DATE	DURATION TIME (minutes)	SUM OF EVENT AREAS (ppm-mins)	AVERAGE CONCENTRATION FOR EVENT (ppm)	QUANTITY INFLUENT[a] (kgs	lbs)
1100-1200	60	1476	25	0.9	2.1
1200-1300	60	17296	288	11	24
1300-1400	60	10242	171	6.5	14
1400-1417	17	3099	182	2.0	4.3
changed chart speed at 1417					
1417-1500	43	2057	48	1.3	2.9
1500-1600	60	1933	32	1.2	2.7
1600-1700	60	1481	25	0.9	2.1
1700-1800	60	1053	18	0.7	1.5
1800-1900	60	0	0	0	0
1900-2000	60	0	0	0	0
2000-2100	60	0	0	0	0
2100-2200	60	0	0	0	0
2200-2253	53	0	0	0	0
	1608 minutes			35 kg	76 pounds

[a] The effluent Freon concentrations from CA 4 were also monitored. However, because of the infrequent regeneration schedule, it may be assumed that the total quantity of Freon influent to CA 4 is the same as the quantity emitted, over the operation time scale. For this reason, only the influent quantity is reported in this table.

in Table 11. The original test plan called for two flow rate measurements to be taken at each site tested. This was done successfully at Sites 1, 2, 3, 6, and 7, and at the influent ducts of CA 3 and CA 4. Because testing was performed for only one work cycle at Site 4, only one air flow measurement was performed.

At Site 5, only one measurement was taken because the field crew found it extremely difficult to measure air flow rates at any time other than the middle of the day (the emission source connected to the Site 5 duct was used intermittently for only one shift per day). Generally, the time the equipment was used was less than that required to accurately measure the flow. For this reason, only one flow rate measurement was taken at Site 5.

A similar problem occurred in measuring the sources in the Clean Room 12 area. Due to the infrequent and intermittent use of these sources, the field crew found it difficult to measure air flow rates. Often, the exhaust fans are not on for a sufficient length of time to permit an accurate measurement. Sites 6, 7, and 8 were nearby, and the field crew had to rush up and down the narrow walkway between sites when they heard a source fan turn on. Due to the awkwardness of the situation, only one flow rate measurement was taken at Site 8.

The small difference between influent air flow rate measurements taken in the morning and evening of 16 September at the CA 4 inlet is most likely due to the opening and closing of source vents and duct fans connected to the CA 4 system. Great effort was expended to ensure that all source vents contributing to CA 4 remained open for the duration of the test. However, this did not always occur. In some cases, workers complained of the excess noise levels resulting from the use of the contributing fans and vents. Often, these fans were turned off despite the presence of warning signs instructing the workers not to turn off fans and close vents.

The difference between influent and effluent air flow rate measurements taken at CA 4 on 16 September is 7.2 percent. This is remarkably low, because laminar conditions did not exist in the CA 4 influent duct. Furthermore, 7.2 percent is no more significant than variations measured at the other sites (compare the air flow rate measurement taken at Site 6). This is discussed more fully in Section VII.

2. Air Flow Rate Measurements at Open Faces

Linear air flow rate measurements were taken at the front faces of the process booths connected to CA 3 and CA 4. The results of these measurements are presented in Table 12.

TABLE 11. FLOW RATE MEASUREMENTS FOR SITES 1-8 AND CARBON ADSORPTION BEDS 3 AND 4.

Location	Date & Time	Flowrate (scfm)
Site 1	14 Sept 0240	773
	14 Sept 1240	732
Site 2	14 Sept 0250	1132
	14 Sept 1210	1167
Site 3	13 Sept	372
	15 Sept 1430	393
Site 4	13 Sept	425
Site 5	15 Sept 2250	1189
Site 6	15 Sept 2200	154
	16 Sept 1437	164
Site 7	15 Sept 2220	212
	16 Sept 1447	217
Site 8	15 Sept 2235	1285
CA 3 influent	14 Sept 0125	2861
	14 Sept 1340	2883
CA 3 effluent	14 Sept 0050	2790
CA 4 influent	16 Sept AM	2488
	16 Sept 2300	2934
CA 4 effluent	16 Sept 2300	2736

TABLE 12. AIR FLOW RATES AT PROCESS BOOTHS AND WORK STATIONS CONNECTED TO CARBON ADSORPTION SYSTEMS 3 AND 4.

Work Area	Room	Linear Flowrate (fpm)	Process Booth Configuration
Clean Room 3	41E28	150	Freon Booth with 8 inch access ports fitted with slit rubber covers
		200-250	Freon booth with open, 8 inch access ports
	41E27	160	Freon booth with open, 8 inch access ports
	41F26	10	Freon spray booth with open, 8 inch access ports
	41F27	100	TCA hood with slide-up front window; at recommended operating height, the open area is 3.5 feet by 1.5 feet
		200	Freon booth with 8 inch access ports fitted with slit rubber covers
		150	Freon booth with open, 8 inch access ports
	41F28	150-175	Freon booth with open, 8 inch access ports
Clean Room 4	41E24	500	Freon booth with open, 4 inch access ports
	41F24	600	Freon booth with open, 4 inch access ports
		25	Freon or TCA booth with open, 8 inch access ports
	41F21C	125	Small cantilevered booth with open, 8 inch access ports used for Frecn spray can operations
Clean Room 7	41E32	20-40	TCA spray booth with free swinging front face; 8 inch open access ports
		120-140	Freon spray booth with free swinging front face; 8 inch open access ports
		NI	Freon spray booth with free swinging front face; 8 inch open access ports. Fan not in operation

TABLE 12. AIR FLOW RATES AT PROCESS BOOTHS AND WORK STATIONS CONNECTED TO CARBON ADSORPTION SYSTEMS 3 AND 4 (CONCLUDED).

Work Area	Room	Linear Flowrate (fpm)	Process Booth Configuration
Clean Room 10	41K29	100-200	Freon spray booth with free swinging front face and 8 inch access ports fitted with slit rubber covers
	41H28	250 with fan <70 without fan	Freon spray booth with 8 inch access ports fitted with slit rubber covers; Exhaust fan is extremely loud, thus it is generally not left on
Clean Room 2	41C23	80-110 with pad activation 10-30 without pad activation	Freon spray booth with slide-up front window; equipped with open, 8 inch access ports; booth is footpad activated
Process Rooms	41H25	140-200	Freon booth with open, rectangular face; dimensions of open area are 1 feet by 3.5 feet
	41H22	750-1000	Freon spray booth with open, 4 inch access ports
	41H17	50	Freon booth with open, rectangular face; dimensions of open area are 3 feet by 2.5 feet
		300	Freon booth with 8 inch access ports fitted with slit rubber covers
	41J25	200	Freon spray booth with latching, free swinging front face; 8 inch access ports fitted with slit rubber covers
	41L20	200-300	Freon spray booth with latching, free swinging front face; 8 inch access ports fitted with slit rubber covers

(Note that the diameters and open areas reported here are approximate)

SECTION IV

ENGINEERING EVALUATION AND DISCUSSION

In this section, the implication of the results presented in Section III are discussed. Each of the three principal areas (Peacekeeper, Refurbishing, and Clean Room 12) is discussed in detail in Sections A through C. In Section D, a general description of CA system operation is included to explain fully the engineering evaluation (presented in D and E) of the sites denoted as CA 3 and CA 4. In Section F, the results from the field testing efforts are compared to the results of an inventory performed on this facility in July 1988.

A. SITES 1 AND 2 -- PEACEKEEPER AREA

It is not known specifically how many point sources of Freon are connected to the exhaust duct denoted as Site 1. Due to the moderately high emission rate measured during this test, it is suspected that more than one source of Freon emission is connected to the Site 1 duct. Emissions totalling 32 kg (70 pounds) were measured during the Site 1 test. Assuming 260 working days per year, and assuming that the operating cycle measured is normal (i.e., this work station always operates three shifts per day, 5 days per week), then the total quantity of Freon that is emitted annually from the sources connected to this exhaust duct is on the order of 5,500 kg (12,200 pounds).

Before testing efforts were initiated at Newark AFB, attempts were made to ensure that the operations tested would be representative of activities normally occurring throughout the year. In comparing the results obtained for a specific site from two consecutive days, it was determined that operational variability is quite high. In fact, some sites varied by more than 40 percent, and one site varied by nearly 80 percent! Because of this variability factor, a reasonable percent range should be applied to the results obtained from Site 1 (as well as all the other sites).

A 25-percent variability range was selected. Although 25 percent is on the low end of the operation variations observed during the test, it should be considered that the average daily emissions rate reported here was obtained during the 2-day period in which these variations were observed. Thus the day-to-day variations have been somewhat taken into account.

Assuming that the operating cycle measured during the emissions testing period at Site 1 is within 25 percent of what could be considered "normal" operation, a reasonable estimate for the total amount of Freon emitted annually from Site 1 is 4,160 to 6,930 kg (9,150 to 15,250 pounds).

It is not known specifically how many point sources of Freon are connected to the exhaust duct denoted as Site 2. Due to the high emission rate measured during this test, it is suspected

that there are multiple sources of Freon emissions vented to the Site 2 duct. Total emissions of 112 kg (246 pounds) were measured over the duration of the Site 2 test. Assuming that there are 260 working days per year, and assuming that the operating cycle measured is normal (i.e., this work station always operates three shifts per day, 5 days per week), then the total quantity of Freon that is emitted from this facility annually is on the order of 19,400 kg (42,700 pounds). Assuming that the operating cycle measured during the emissions testing period is within 25 percent of what could be considered "normal" operation, a reasonable estimate for the total amount of Freon emitted annually from Site 2 is 14,600 to 24,300 kg (32,000 to 53,500 pounds).

B. SITES 3, 4, AND 5 -- REFURBISHING AREA

As described in Section III, the exhaust duct denoted as Site 3 is connected to a flush station located in the refurbishing area. Total emissions of 13 kg (29 pounds) were measured over the duration of the Site 3 test. Assuming that there are 260 working days per year, and assuming that the first 24-hour operation cycle measured is "normal" (i.e., this work station always operates one shift per day, 5 days per week), then the total quantity of Freon that is emitted from this site annually is on the order of 3,400 kg (7,500 pounds). The data from the first 24-hour measurement cycle are used solely in this evaluation because the data from the second 24-hour cycle are incomplete, as indicated in Table 3. Assuming that the operating cycle measured during the emissions testing period is within 25 percent of what could be considered "normal" operation, a reasonable estimate for the total amount of Freon emitted annually from Site 3 is 2,500 to 4,200 kg (5,570 to 9,300 pounds).

The exhaust duct denoted as Site 4 is connected to a spray booth located in the refurbishing area. Total emissions of 1.8 kg (4.0 pounds) were measured over the 1.3-day duration of the Site 4 test. Assuming 260 working days per year, and assuming that operation cycles measured during the 1.3 days are typical for this source (i.e., it is always operated one shift per day, 5 days per week), then the total quantity of Freon emitted from this site annually is on the order of 390 kg (860 pounds). Assuming that the operating cycle measured during the emissions testing period is within 25 percent of what could be considered "normal" operation, a reasonable estimate for the total amount of Freon emitted annually from Site 4 is 290 to 490 kg (640 to 1,070 pounds).

As described in Section III, the exhaust duct denoted as Site 5 is connected to three vented work stations located in the refurbishing area; however, only one work station appears to be a Freon emission source. Total emissions of 1.4 kg (4.0 pounds) were measured over the duration of the Site 5 test. Assuming 260 working days per year, and that operation cycles measured during the test are typical for this source (i.e., it is always operated one shift per day, 5 days per week), then the total quantity of Freon emitted from this site annually is on the order of 200 kg

(450 pounds). Assuming that the operating cycle measured during the emissions testing period is within 25 percent of what could be considered "normal" operation, a reasonable estimate for the total amount of Freon emitted annually from Site 5 is 152 to 250 kg (340 to 560 pounds).

C. SITES 6, 7, and 8 -- CLEAN ROOM 12

Continuous Freon concentration measurements at Site 6 occurred over a 42-hour period. As indicated by the results given in Table 6, this source is used quite frequently for two shifts per day; however, overall Freon usage appears to be relatively low. Total emissions of 16 kg (35 pounds) were measured over the duration of the Site 6 test. Assuming that there are 260 working days per year, and assuming that operation cycles measured during the test are typical for this source (i.e., it is always operated two shifts per day, 5 days per week), then the total quantity of Freon that is emitted from this site annually is on the order of 2,450 kg (5,360 pounds). Assuming the operating cycle measured during the emissions testing period is within 25 percent of what could be considered "normal" operation, a reasonable estimate for the total amount of Freon emitted annually from Site 6 is 1,840 to 3,060 kg (4,040 to 6,730 pounds).

Continuous Freon concentration measurements at Site 7 occurred over a 41-hour period. As indicated by the results given in Table 7, this source is used infrequently during two shifts per day; however, large quantities of Freon are used when this source is activated. Total emissions of 17 kg (37 pounds) were measured over the duration of the Site 7 test. Assuming 260 working days per year, and assuming that operation cycles measured during the test are typical for this source (i.e., it is always operated two shifts per day, 5 days per week), then the total quantity of Freon that is emitted from this facility annually is on the order of 2,960 kg (6,510 pounds). Assuming the operating cycle measured during the emissions testing period is within 25 percent of what could be considered "normal" operation, a reasonable estimate for the total amount of Freon emitted annually from Site 7 is 2,220 to 3,700 kg (4,900 to 8,140 pounds).

Continuous Freon concentration measurements at Site 8 occurred over a 42.5-hour period. As indicated by the results given in Table 8, this source is used quite frequently for two shifts per day, and large quantities of Freon are used when this source is activated. Total emissions of 113 kg (248 pounds) were measured over the duration of the Site 8 test. Assuming 260 working days per year, and assuming the operating cycle measured during the test is typical for this source (i.e., it is always operated two shifts per day, 5 days per week), then the total quantity of Freon emitted from this facility annually is on the order of 16,790 kg (36,940 pounds). Assuming the operating cycle measured during the emissions testing period is within 25 percent of what could be considered "normal" operation, a reasonable estimate for the total amount of Freon emitted annually from Site 8 is 12,600 to 21,000 kg (27,700 to 46,200 pounds).

D. CARBON ADSORPTION SYSTEM 3

1. Influent Concentration Monitoring Results

Continuous Freon concentration measurements at CA 3 occurred over a 55-hour period. A total of 52 hours worth of data were taken. As indicated by the results given in Table 9, many of the sources vented to CA 3 are used three shifts per day. The fact that the usage rates associated with these sources are extremely variable is also indicated in Table 9. The total quantity of Freon influent to CA 3 in the 52-hour period studied is 272 kg (598 pounds). Assuming 260 working days per year, and assuming that the operating cycles measured during the test are typical for this system, the total quantity of Freon influent to CA 3 annually is on the order of 33,000 kg (72,600 pounds). Assuming that the CA 3 operating cycle measured during the emissions testing period is within 25 percent of what could be considered "normal" operation, a reasonable estimate for the total amount of Freon deposited in CA 3 annually is 24,500 to 41,250 kg (54,500 to 90,750 pounds).

According to the information presented in Table 9, it is difficult to assess a daily "average" influent concentration to CA 3. For example, during the first 24-hour period studied, the total quantity of Freon deposited in the bed is 95 kg (210 pounds), and during the second 24-hour period, approximately 111 kg (244 pounds) were deposited. If the results of the remaining 7 hours of data were extrapolated to 24 hours (and corrected for the fact that the influent concentration between 1000 and 1700 is typically 40 percent higher than between 1700 and 1000), the third day's deposition of Freon in the bed would be 169 kg (372 pounds). The daily deposition rate estimated for CA 3 is 125 kg (280 pounds), which represents an average of the three usage cycles measured. This assumption may be somewhat low.

2. Determination of Optimal Regeneration Schedule

During an initial site visit to the Newark AFB facilities in February 1988, it was learned by Acurex and EPA personnel that both CA 3 and CA 4 were regenerated only once per year. It was suggested by Acurex to EPA and the Air Force that the infrequent regeneration of the bed could account for a significant fraction of the unrecovered Freon. Subsequent communications between Acurex, EPA, and Newark AFB presented possible solutions to the bed regeneration problem. Based on these suggestions, Newark AFB personnel experimented to some extent to find an acceptable regeneration schedule. Because the carbon adsorption systems in general, and CA 3 in particular, were identified as potentially significant emissions sources, an extensive test program focusing on CA 3 operation was developed. The objectives of the tests were

- To determine the loading rate of the bed under normal operation.
- To determine the breakthrough rate under normal operation.
- To determine whether or not breakthrough occurs before the bed is saturated.

To understand these objectives thoroughly, it is necessary to give a brief description of a typical CA bed operation cycle. When process air containing solvent vapor passes through a CA bed, the solvents are picked up, or adsorbed, on the activated charcoal contained in the bed. Depending on the physical attributes of the solvent (i.e., polarity and molecular weight), the solvent molecules may be either tightly or loosely bound to the charcoal.

Tightly bound compounds are not easily reentrained in the process flow of air, so they do not migrate easily through the bed. Compounds that are not tightly bound may become reentrained, and migrate through the bed. Breakthrough (escape of solvent vapors from the CA bed) may be due to bed saturation (when all the active sites on the charcoal are occupied) or to solvent migration. The optimal design for a CA bed is one in which saturation occurs simultaneously with breakthrough. The influent solvent concentration is a key parameter in determining whether or not breakthrough occurs simultaneously with saturation. Process air streams from sources that operate intermittently contain variable concentrations of solvent. If intermittent operation results in large quantities of clean process air passing through the bed between operations, significant solvent migration (and therefore early breakthrough) could result.

Just prior to breakthrough, a CA bed should be regenerated to recover the solvents collected by the bed, and to reactivate the charcoal. This is generally done by stripping the bed with dry steam, which condenses, heats the bed and causes the solvent to volatilize off the charcoal. Moisture that remains in the bed does not affect operation, because polar water molecules will be preferentially replaced by organic (non-polar) molecules. The exception to this is condensed moisture physically clogging the capillaries in the charcoal.

Regeneration of CA 3 occurred between 0900 and 1100 on 14 September. System shutdown was not required during regeneration; thus, CA 3 was not taken offline at any time during the regeneration cycle. Breakthrough was detected at approximately 1200 on 15 September. In the 27 hours between regeneration and breakthrough, approximately 120 kg (264 pounds) were measured in the influent duct. The density of pure Freon is 1.57 kg per liter (or 13.1 pounds per gallon); thus, the total volume of liquid Freon that was vented to CA 3 before breakthrough was 76.4 liters (20.2 gallons). Assuming that CA 3 is composed of two 1,000-pound beds, and assuming a working capacity for Freon of 10 percent of carbon by weight, the CA system should collect a maximum of 91 kg or 58 liters (200 pounds or 15.3 gallons). This amount is lower than the actual amount collected.

A carbon adsorption bed manufacturer was contacted to help explain this inconsistency. It was learned that bed working capacities are extremely variable, and they can change with age. Thus the selection of a 10 percent working capacity is somewhat arbitrary. In addition, it was learned that the rated size of any given CA system is generally lower than the

actual bed size (i.e., more carbon is present in the bed than the operating manual reports). Thus, CA 3 may contain more than 1,000 pounds of carbon in each bed. The combination of these two design factors can cause a 20-*percent underprediction* of the quantity of solvent a specific bed will recover. Finally, the range of error on the Freon monitoring system is approximately ±20 percent (see Appendix B). All of these factors combined account for the apparent loading capacity discrepancy.

The primary result of the CA 3 test is that breakthrough of solvent vapors does not seem to occur prior to bed saturation. This implies that current bed operation is acceptable; however, the regeneration schedule should be altered. As described previously, immediately prior to initiation of the field tests in September 1988, a new regeneration schedule was implemented in which bed regeneration occurs three times per week on Monday, Wednesday, and Friday mornings. The test results indicate that regenerating CA 3 three to four times per week is probably sufficient; however, the current regeneration schedule should be altered. For example, if the bed is regenerated Friday morning, approximately 15 hours of operation occur before the weekend recess. Over the weekend, the 10-hp fan located upstream of the bed operates continuously, and in all likelihood, some of the Freon captured by the bed on Friday is "blown" out of the bed by Sunday night. Thus, when the bed is again regenerated on Monday morning, only *a fraction of the Freon* that was collected on Friday afternoon is recovered. The intermittently heavy operating cycle that exists at Newark AFB makes it difficult to anticipate when breakthrough will occur.

The optimal solution to the intermittency problem is to install a feedback system in the CA 3 effluent duct. When breakthrough is detected, the CA bed is automatically switched over to regeneration mode. In this way, the guesswork involved in deciding when to regenerate is eliminated. To install such a system on CA 3 should cost less than $10,000. If a feedback system is installed, the CA systems may require some additional alterations.

As with most CA systems, CA 3 is equipped with two carbon adsorption beds. Normally, systems of this type are operated in a single-pass mode, in which all the process air is passed through one bed. When bed saturation and/or breakthrough occurs, the process air is passed through the second bed while the first bed is regenerated. In this way, the potential for breakthrough in one bed during regeneration of the other bed is eliminated. In addition, the associated steam generation unit can be somewhat smaller, because only enough steam to regenerate one bed per regeneration cycle is required, rather than two beds regenerated sequentially.

CA 3 is not operated in single-pass mode. Currently, the process air stream flowing into the CA 3 system is split between the two carbon beds, which are operated in parallel. When

the system is regenerated, all the process air is directed through one bed while the other bed is regenerated. When one bed is finished regenerating, the process air flow is directed through it, and the other bed is regenerated. When both beds have been regenerated, the system reverts to split pass operation.

The problem with this mode of operation is that, while the first bed is being regenerated, the solvent vapor present in the air bypassed through the other bed is not adsorbed (and therefore passes through the bed into the effluent). This is because breakthrough and/or saturation has already been established in the bypass bed (otherwise, the system would not require regenerating). This "dual-pass" operation mode is very unusual for two-bed carbon adsorption systems. No references to a system that operates in this manner could be found in a review of technical documents and discussions with CA system manufacturers. Thus, when a feedback control system is installed, additional work should be done to convert the system to single-pass operation. Each 1,000-pound bed should process the 2,800 scfm flow rate with little difficulty.

An improved set regeneration schedule should be adopted immediately for CA 3 in the interim before a feedback control system is installed. A set regeneration schedule should take into consideration the operating cycles of the work stations vented to CA 3. At Newark AFB, operations at work stations vented to CA 3 begin at approximately midnight on Sundays, and terminate at approximately midnight on Fridays. If breakthrough occurs after approximately 30 hours of normal operation, then the regeneration schedule must be adapted to reflect this. Regeneration should probably occur on Tuesdays at approximately 0600, Wednesdays at approximately 1200, Thursdays at approximately 1800, and Fridays at approximately 2400. The bed is therefore empty when operations begin again on Sunday night. Please note that this schedule was developed for CA 3 assuming the current mode of operation (i.e., in the split-flow mode). If the CA 3 system is converted to single-pass operation and a set regeneration schedule is adopted, then the regeneration of each bed should occur every 15 hours, so the entire system is regenerated once every 30 hours.

If a set regeneration schedule is utilized, the effluent concentrations should be checked daily to ensure that the proposed schedule is adequate. This is important because of the dynamic nature of the operations taking place in the process rooms vented to CA 3. For example, CA 3 was regenerated on Monday morning, 12 September, yet breakthrough was already detected when the test started on Tuesday morning, 13 September. In this case, breakthrough occurred in approximately 25 hours, and because the regeneration schedule was set at 48-hour intervals, there was a period of nearly 23 hours in which Freon emissions were not controlled.

Of course, the need for guesswork and the daily monitoring of effluent concentrations is eliminated with the use of a feedback control system, making it the optimal solution.

3. Evaluation of Current Freon Emission Source Integration of Carbon Adsorption System 3

At the onset of this test program, it was anticipated that a possible strategy for making CA 3 operate more efficiently would be to better integrate the sources contributing to the influent. This strategy was motivated by the fact that continuously operated fans coupled with intermittent source operation will cause large quantities of uncontaminated air to pass through the CA system. Such an operation results in the reentrainment and possible emission of solvent vapors before bed saturation occurs. As described previously, this combination will reduce the CA system emission control efficiency. It was anticipated that improved system integration could be achieved primarily through downsizing or elimination of the large, 10-horsepower fan located immediately upstream of the CA bed (the fans are used to ensure that the requisite air flow rates are maintained through process booths located a large distance from the connecting carbon adsorption bed).

For reasons of health and safety, the current operating flow rates through the process booths connected to CA 3 must be fully characterized before the suggestion of downsizing or eliminating the fan can be made. As required by OSHA, the minimum flow rate into the process booths is 100 linear feet per minute. The results of a survey to determine the flow rates through each of the sources contributing to the CA 3 influent was presented in Table 12. The results in Table 12 indicate that some booths are on the lower limit required by OSHA; thus, the downsizing of the fan associated with CA 3 may not be possible. Furthermore, it was found that fan operation does not seem to cause bed breakthrough prior to bed saturation (as described previously). For these two reasons, it was determined that alteration of the CA 3 ventilation system is not necessary.

E. CARBON ADSORPTION SYSTEM 4

1. Influent Concentration Monitoring Results

Continuous Freon concentration measurements at CA 4 occurred during a 27-hour period. As indicated by the results given in Table 10, the sources vented to CA 4 are used one shift per day. The total quantity of Freon influent to CA 4 in the 24-hour period studied is 35 kilogram (76 pounds). Assuming 260 working days per year, and assuming that operating cycles measured during the test are typical for this system, the total quantity of Freon that is influent to CA 4 annually is approximately 9,100 kg (20,020 pounds). Assuming the operating cycle measured during the emissions testing period is within 25 percent of what could be considered "normal" operation, a reasonable estimate for the total amount of Freon deposited in CA 4 annually is 6,830 to 11,380 kg (15,020 to 25,030 pounds).

2. Determination of Optimal Regeneration Schedule

As described in Section III, testing during an entire regeneration cycle for CA 4 was not possible due to a malfunction of the condensed liquid separator that operates in conjunction with the regeneration system. It was therefore not possible to determine an optimal regeneration schedule based on measurement results. However, by assuming that the 35 kg (77 pounds) of solvent measured over the 27-hour test represents a typical duty cycle for CA 4, a reasonable schedule can be calculated.

Because the CA 4 system is the same size as the CA 3 system (i.e., it comprises two 1,000-pound adsorption beds), it can be assumed that the same design parameters apply. Theoretically, the CA 4 system should hold 58 liters (15.3 gallons) of Freon, however (for reasons described previously), the actual amount deposited in the bed may be as high as 76 liters (20 gallons). Assuming a maximum system load of 66.9 liters (17.6 gallons), the bed capacity of CA 4 should be approximately 105 kg (230 pounds). At a usage rate of 35 kg (77 pounds) per day, the bed should become saturated within 3 days. Based on this evaluation, it would appear that regeneration should occur after 3 days of operation.

It is very likely that intermittent operation of the sources connected to CA 4, coupled with the low influent Freon concentration, will cause solvent migration through the bed, which in turn, will result in breakthrough before bed saturation. A system operating under these conditions cannot function at maximum efficiency, because regeneration is required before bed saturation occurs. Unfortunately, it was not possible to establish the validity of this theory; however, it should be considered a very real possibility.

There are several possible solutions to this problem. One may eliminate air flow during times that CA 4 is not being loaded. This can be accomplished in two ways. The least expensive option is to turn off the 10-hp fan associated with CA 4 during process downtime (i.e., during the second and third shifts and over the weekend). Continuous flow through the bed (and the resulting reentrainment and release of Freon vapors) will therefore be eliminated. An alternative is to install a control circuit on the CA 4 fan so that it operates only when a connecting process booth is in use (similar to the fans that operate in the exhaust ducts of the pad-activated sources).

A second solution is to design the regeneration schedule to accommodate the possibility of solvent breakthrough before saturation. This is not an optimal solution, because excessive regeneration of a CA bed reduces the life of the bed and increases the required carbon change-out rate.

In addition to reducing intermittent operation by turning off the fan during system downtime, the best way to prevent breakthrough and subsequent release of Freon is to install

a feedback control system, by which regeneration is initiated whenever breakthrough is detected in the effluent duct.

3. Evaluation of Current Freon Emission Source Integration of Carbon Adsorption System 4

The integration of the sources connected to CA 4 was evaluated in a manner similar to that applied to the source integration of CA 3. The results of a survey to determine the flow rates through each of the sources contributing to the CA 4 influent are presented in Table 12. It was found that the flow rate through some of the booths vented to CA 4 are on the lower limit required by OSHA, thus downsizing the fan associated with CA 4 (and alteration of the ventilation system) is not recommended.

F. COMPARISON OF THE TEST RESULTS WITH THE INVENTORY SURVEY PERFORMED IN JULY 1988

1. Comparison of Test Results with Inventory Survey Results

The results of a solvent inventory performed at the Newark AFB Building 4 facility were used to develop the test matrix used in the emissions profile evaluation and process characterization of the facility. The results of the emissions evaluation and process characterization (presented in this report) are compared to the results of the inventory in this section.

In the inventory report, the estimated quantity of Freon emitted from spraying and flushing operations is 108,000 kg (238,000 pounds). The results of the testing efforts performed on vented sources indicate that a total of 93,000 kg (204,600 pounds) was measured in the exhaust ducts denoted as Sites 1-8 and CA 3 and 4. However, as discussed in the previous sections, the quantity emitted from these sources annually could be as high as 116,550 kg (256,400 pounds). Thus, the quantity of Freon emitted from process booths estimated in the inventory report is in acceptable agreement with the test results.

In the inventory report, a significant fraction of the Freon lost to evaporation comes from ultrasonic cleaners and degreasers. It is quite certain that few, if any, of the degreasers are connected to exhaust ducts vented either to a carbon adsorption system, or the outside. In addition, it is believed that few of the ultrasonic cleaners are vented. The inventory estimated that these sources contribute 37,700 kg (83,000 pounds) per year to the total losses.

This number was obtained by querying the Newark AFB employees on how often the ultrasonic cleaners are filled, and how often the degreasers are topped off. These activities are performed by filling containers with solvent from Freon taps, and transporting the containers to the degreasers or ultrasonic cleaners. Because these are quantized processes (i.e.,a certain number of refills are required per day), the workers specified precisely how much solvent is required daily to maintain operations. For this reason, there is great confidence in the quantity estimated for these sources.

Emissions from these uncontrolled sources were not evaluated during this test series because they are not vented. These sources should be vented as soon as possible, and the resulting emission rate should be evaluated to determine the resulting impact they may have on CA system loading rates.

The inventory report concludes that, although nearly half of the process rooms are vented to one of the two CA systems, only 33 percent of the Freon lost to evaporation from process operations passes into the CA systems. Conversely, 67 percent of the Freon lost from process operations is NOT vented to the CA systems. The test results indicate that a total quantity of 92,870 kg (204,310 pounds) is vented from the sites tested. Of this quantity, 51,130 kg (112,480 pounds), or 55 percent, is NOT vented to the CA beds. However, if one considers the 36,700 kg (83,000 pounds) that is lost from the degreasers and ultrasonic cleaners (which, it is believed, are also not vented), a total of 130,570 kg (287,250 pounds) is lost annually and, of that, 88,830 kg (195,420 pounds), or 68 percent, is NOT vented to the CA systems. This is in excellent agreement with the inventory results.

2. Comparison of Test Results to Actual Freon Loss Rates Reported in the Inventory Survey

The mass balance results of the inventory survey performed in July 1988 pertain to the period June 1987 to June 1988. The survey established that, during this time period, 270,900 kg (596,000 pounds) of Freon was purchased, and 18,450 kg (40,600 pounds) was manifested for disposal. Thus, 252,450 kg (555,400 pounds) was lost due to evaporation. Of this quantity, 194,000 kg (427,000 pounds) was accounted for in the inventory study. The evaporated Freon was not recovered due to poor CA system maintenance, non-vented sources, and vented sources that are ducted directly to the atmosphere.

The test results can account for as much as 116,100 kg (255,420 pounds) if the highest emissions loss range is assumed (+25 percent). By including the quantity of Freon lost from nonvented sources estimated in the inventory (calculated to be more than 44,000 kg [97,000 pounds]), the total accounted loss is 156,000 kg (343,000 pounds). The remaining Freon may be accounted for, to some extent, by the process changes that were adopted by Newark AFB in the interim between the early part of 1988 and the time the test was performed in September 1988. One of the most significant changes is the elimination of losses from the venting of Freon holding tanks.

Until September 1988 (immediately prior to testing), there were at least three Freon holding tanks that were vented directly to CA 3. None of these tanks was equipped with sealing valves; rather, the venting ducts were open completely to the CA 3 ventilation system. The continuously operated 10-hp fan draws air through CA 3 was constantly pulling Freon vapors out of these tanks (which are never empty), 24 hours per day, 7 days per week. Because Freon is

very volatile, the operation of the large fan caused significant quantities of Freon to be vented to CA 3.

The elimination of this source immediately prior to testing (in early September 1988) resulted in a significant lowering of the quantity of Freon lost from Newark AFB annually. Because this source was eliminated before testing, the impact it had on the overall emissions from Newark AFB could not be quantified. To accurately calculate the reduction in emissions due to the elimination of this source, it would be necessary to completely characterize the CA 3 ventilation system (i.e., determine the duct sizes from every source to the CA bed; the draw through each booth both during operation and while it is idle; the draw from each booth equipped with its own exhaust fan; the distances from the sources to the CA bed). Obviously, this is a complicated problem and out of the scope of this report. However, an order-of-magnitude estimate of the Freon losses can be derived by making a few basic assumptions:

- Given that the fan associated with the CA 3 bed is 10-hp, and that the flow rate through the bed is approximately 2,800 scfm, the total pressure drop due to the parallel integration of all the sources ventilated by the fan is approximately 7 inches w.c.
- The pressure drop across the connection between the open storage tanks and the venting duct is small (0.01 inches w.c.). This estimate is probably low, because there are 14 sources connected to CA 3, which implies an average pressure drop of 0.5 inches w.c. across each source. Some are nearby and some are located quite a distance from the bed.
- The Freon concentration in the vicinity of the junction is assumed to be 15 percent due to mixing of the duct air and the Freon vapor released from the tank. This assumption is most likely quite low, because Freon is very volatile.

Applying Bernoulli's equation to determine the flow velocity in a pipe with a 0.01 inch w.c. pressure drop, a flow rate of 2.2 cfm is calculated. At 15 percent by volume Freon, this results in 0.3 cfm of Freon per minute, or 29,200 kg (64,240 pounds) per year. This value was obtained by making some very conservative assumptions; actual emission rates could have been twice as high or higher. Obviously these calculations were performed based on assumptions made without the benefit of measured results. However, they do give an indication of the significant impact this source had on annual Freon emissions prior to its elimination.

By adding the estimated loss from nonvented holding tanks to the sum of accounted Freon evaporation losses, a total of 182,000 kg (400,400 pounds) can be accounted for. Other process changes that occurred between the inventory survey and the emissions testing, such as the increased use of Cyl-sonic™ cleaning in the Clean Room 12/Refurbishing area, have doubtlessly contributed to a reduction in emissions losses. However, quantifying the impact that the reduction or elimination of emissions from these sources have on the overall emissions from

Newark AFB is out of the scope of this project. In addition, other emissions sources that have not been identified and vented directly to the outside may also exist, and therefore contribute to the overall losses.

G. STRATEGY FOR CONTROL OF FREON EMISSIONS FROM SOURCES TESTED

The two locations that have uncontrolled Freon emission sources are the Peacekeeper and Clean Room 12/Refurbishing areas. The most cost-effective approach for controlling Freon emissions from these sources is to integrate the Peacekeeper source ventilation system with the CA 3 and CA 4 ventilation systems, and install a dedicated solvent recovery system to control emissions from the Clean Room 12/Refurbishing area. The test results indicate that the CA 4 system has sufficient capacity to process emissions from additional sources. Therefore, ductwork should be modified to divert sources currently vented to the CA 3 control unit to the CA 4 control unit. The Peacekeeper emission sources should then be tied into the CA 3 control unit.

An additional carbon adsorption vapor recovery system equipped with a loading capacity similar to the CA 3 and CA 4 units may be installed to control the emissions from the Clean Room 12/Refurbishing area. A CA system meeting the flow rate and loading specifications of 2,800 cfm and 226 kg per hour, respectively, will cost on the order of $285,000. This reflects only the equipment and installation costs. In addition, the system includes a steam stripper, but does not include a steam generator.

SECTION V
CONCLUSIONS AND RECOMMENDATIONS

A. CONCLUSIONS

From the data collected in this test effort (presented in Section III) and the engineering evaluation results (presented in Section IV); the following conclusions can be drawn:

- The quantity of Freon emitted from the Peacekeeper, Refurbishing, and Clean Room 12 areas total more than 54,432 kg (120,000 pounds) per year; thus emissions from these areas should be targeted for major reduction.
- The emission sources not vented from process areas should be placed in hoods vented to a solvent vapor recovery system.
- The current carbon adsorption system regeneration schedules are inadequate. This is discussed fully in Section IV.
- The test results are in general agreement with the results obtained from the Newark solvent chemical inventory survey performed prior to testing (1).
- The implementation of the recommendations made in this report should result in an emissions reduction of more than 113,400 kg (250.000 pounds) annually.

B. RECOMMENDATIONS.

The recommendations made in this section are of two types: those that can be adopted almost immediately and those that will take some time. These "short-term" and "medium-term" recommendations are presented separately. The medium-term recommendations are

- Significant emissions from the Peacekeeper area should be eliminated by connecting the source exhaust ducts from the Peacekeeper area to the CA 3/CA 4 network. Based on the test results, it does not appear necessary to install a new CA system that is dedicated to the Peacekeeper area.
- Under current operations, CA 4 is significantly underutilized compared to CA 3, which is operating near maximum capacity. It is recommended that Newark AFB either connect the Peacekeeper area exhaust ducts to CA 4, or offload most of the CA 3 sources to CA 4, and connect the Peacekeeper exhaust ducts to CA 3. CA 3 and CA 4 should be integrated so that approximately 130 kg (286 pounds) is influent to both CA 3 and CA 4. With this new integration strategy, the CA systems would be operating near maximum capacity, however, this recommendation should be implemented only if the installation of additional significant sources is not planned.
- Based on the results of air flow rate measurements taken at each of the point sources vented to the CA systems, the 10-hp fans located upstream of each CA system should

be capable of maintaining a safe ventilation flow rate through each source. Because the 10-hp fans are already in place, it can be safely assumed that the draw from these fans is not too large for the CA systems to handle. However, some flow balancing will be required after the sources are integrated to ensure that sufficient ventilation air passes through each source.

- A separate solvent vapor recovery system should be installed to control emissions from the Refurbishing and Clean Room 12 areas. Under current operations, these areas emit 106 kg (233 pounds) per day; thus, a system similar to those currently on site should suffice. Carbon adsorption is a very effective means of controlling Freon emissions if properly maintained.
- The emissions sources that are currently uncontrolled (i.e., degreasers and ultrasonics), should be vented to a vapor recovery system. However, the cumulative contribution from these sources could have a significant impact on the recovery system operation. Thus, as soon as they are vented, the contribution from these sources should be quantitized to assess their potential impact. It is possible that these sources are responsible for the emissions of up to 68,040 kg (150,000 pounds) of Freon per year.
- A means of determining Freon evaporation rates in the significant emission source areas (i.e., Peacekeeper, Refurbishing/Clean Room 12, Clean Room 3) should be installed. In this way, the impacts of changes in operating areas on CA bed performance can be determined. This may be accomplished by installing flow meters on Freon supply and waste lines from these areas, and adopting a logging system for waste cans of Freon that are hand carried to holding tanks.

The short-term recommendations are

- Feedback control loops should be installed at the exits of both CA systems to eliminate the possibility of emitting Freon vapor into the environment due to CA bed breakthrough.
- CA systems 3 and 4 should be converted from split-flow operation to single-bed operation (see Section IV).
- Until feedback control loops are installed in the CA bed effluents, the regeneration schedules for CA 3 and CA 4 described in Section IV should be adopted. There may be some fine tuning involved due to the dynamic nature of the overall operation.
- Freon emissions from CA 4 due to the intermittent duty cycle of the point sources vented in CA 4 should be significantly decreased. The most cost-effective means of controlling these emissions is to turn off the 10-hp exhaust fan located upstream of the

bed during process downtime (i.e., weekends, and second and third shift). This will reduce the possibility of solvent migration through the bed and subsequent breakthrough. This is discussed fully in Section III.

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APPENDIX A

QUALITY ASSURANCE/QUALITY CONTROL

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As described in the Quality Assurance/Quality Control (QA/QC) section of the test plan, there were several critical measurements in this test series. The two most critical measurements were the air flow rate measurements, and the Freon concentration measurements in ducts exhausted directly to the outside and to the CA beds.

A total of 12 sites were monitored for Freon concentrations; 10 of these sites were considered critical (the remaining 2 are CA exhaust effluent ducts that were monitored only to determine breakthrough status). Due to the multiple revisions made to the test plan, there were some changes made in the text that were not included in the QA/QC document tables. The data quality objective (DQO) in the text for precision and accuracy is ±30 percent, yet Table 1-1 in the QA plan was never changed to reflect this.

A. AIR FLOW RATE MEASUREMENTS AT BOOTH FACES

As discussed in the QA plan, the dynamic nature of this measurement is such that duplicate measurements may not be comparable. It was hoped that some assessment of data quality could be done by summing up the air flow rates through the process booths connected to a CA system, and comparing this value to the flow rate measured in the CA influent duct. However, it was learned during the test that this was impractical.

To get an accurate comparison, the surface area over which the anemometer data are taken must be known. Unfortunately, many of the access port surfaces (where the anemometer data were taken) are faced with flexible, slit rubber covers. It is impossible to measure the surface area of the openings of these ports while they are in use. Some booths do not have access ports, rather they were fitted with a sliding front window (much like a fume hood). The window height varies, depending on how the unit is used. The position of the window has an effect on the flow rate measured in the duct. For these reasons, a comparison between anemometer flow rate and duct flow rate measurement data was not possible.

With the use of a floor map and information supplied by Newark AFB personnel, the number of process areas connected to CA beds was anticipated before the test was initiated. All of the known sources were measured, and additional sources not known by Acurex personnel to be present were also measured. Thus the completeness for this set of measurements is actually slightly over 100 percent.

B. DUCT FLOW RATE MEASUREMENTS

As with the anemometer data, the duct flow rate measurements during this test were extremely dynamic. Some of the reasons for the dynamic nature of this test series are described above. Nonetheless, multiple flow rate measurements were taken at each site whenever possible. It was originally planned that two flow rate measurements would be taken at each test site. As described in Section II, the intermittent nature of the Newark AFB operations made it

impossible to obtain a second measurement (a process booth may be used once for 1 minute, and not used again for several hours). However, at least one measurement for each site was obtained, and a second measurement was achieved for 60 percent of the sites. Thus, 100 percent of the vented sites were measured at least once, and 8 of the 12 sites were measured twice.

C. FREON CONCENTRATION MEASUREMENTS

The precision of measurement for the Freon emission monitoring tests at the 10 critical sites was obtained by comparing the response of the instrument to successive calibration checks using zero, span, and calibration gases. The DQO for this measurement (see page 2 in Section 1 of the QA plan) was ±30 percent. One hundred percent of the measurements were within this range (in fact, all the measurements were within ±20 percent).

The accuracy DQO for this measurement was ±30 percent. Eight of the 10 measurements were within this range.

Freon concentration measurements that were originally planned for the central vacuum system had to be abandoned due to a faulty Freon monitor. The results of a previous inventory study of this facility indicated that the annual Freon losses due to disposal via the central vacuum system was quite small; this was considered the least important emission source. Because the central vacuum system was not included in the test, only 12 of the 13 sites originally selected for testing were actually tested. The data quality objective for the completeness for this measurement is 90 percent, and 92 percent was achieved. Because no Freon measurements were done at this site, there were no corresponding air flow measurements taken, either.

APPENDIX B
ERROR ANALYSIS

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The time histories of Freon concentration measurements were obtained at various sites at Newark AFB with Gastech Freon Infrared Monitors, and were recorded on strip chart recorders. The area under each concentration/time plot was measured using a planimeter, and converted into ppm-minutes. Conversion factors were obtained from chart deflections attained during calibration measurements. Pure nitrogen was used as the zero gas (nitrogen is non-absorbing at the wavelength used for the measurements), and Freon at 4046 and 1060 ppm in nitrogen were used as the span and calibration gases, respectively.

The chart zero and span gas calibration measurements indicated a drift over time. Therefore, calibrations were performed regularly, and the average length-to-ppm conversion factor for any time interval between two calibrations was obtained as the arithmetic average of the conversion factors from both calibrations. For example, calibration at 1500 could indicate a conversion factor 1000 ppm per inch of deflection, while a second calibration at 1700 could show a calibration factor of 950 ppm per inch of deflection. The concentration data recorded between 1500 and 1700 would be reduced assuming a chart deflection of 975 ppm per inch of deflection.

A. DATA REDUCTION PROCESS

The data reduction process is outlined below:

- Mark two calibration time points, t_1 and t_2, and the time interval Δt between them
- Measure the deflections for the calibration gases at 0 ppm, 1060 ppm and 4046 ppm at time t_1
- Plot calibration gas chart deflection versus ppm and get conversion factor (f) for converting centimeters to ppm at time t_1
- Measure the deflections for the calibration gases at time t_2
- Obtain the conversion factor f_2 at time t_2 in the same way as f_1 was obtained
- Obtain conversion factor $f_{avg} = (f_1+f_2)/2$ for the time interval Δt
- Find peak deflections during interval Δt and convert to ppm
- Select standard area for planimeter calibration A* (preferably a rectangle much larger than a typical chart deflection):

$$A^* = y\Delta t$$

- Obtain planimeter reading P^*, for reference area A^*
- Convert planimeter reference area A^*, to ppm-minutes, Z^*, using the average conversion factor, f_{avg}:

$$Z^* = yf_{avg}\Delta t = f_{avg} A^*$$

- Obtain planimeter readings, Q_i, for area under each Freon emission peak recorded

- Convert each planimeter area reading, Q_i, to ppm-minutes, Z_i:

$$Z_i = Z^* (Q_i/P^*)$$

- Add all the Z_i to obtain the total Freon emission time integral
- Repeat these steps for each subsequent time interval

B. SOURCES OF ERROR

The primary sources of error included

- Zero drift and span drift, causing conversion factor, f, to vary in time, and clipping of some emission peaks
- Error in determining factor f_1, f_2, or f at any time
- Error in measuring reference area A^*, and therefore in reference quantity $Z^* = f_{avg}A^*$
- Error in planimeter readings of areas under Freon emission peaks.
- Error in time interval measurements, Δt
- Errors in measuring chart deflections, Δy

C. ESTIMATION OF ERRORS

There are six principal errors that require estimation:

- Errors in the conversion factor, f
- Errors in Δy and peak ppm values
- Errors in the planimeter reading, P^*, for the reference rectangle
- Errors in the area of reference rectangle, Z^*
- Errors in the planimeter reading, Q_i, for each emission event
- Overall measurement errors for each site

These errors are related and discussed below

1. Error in the Conversion Factor, f

During each calibration check, the chart deflections for 0 ppm, 1060 ppm, and 4046 ppm were determined and plotted against the corresponding concentrations. The plots are presented in Figures B-1 through B-38, in which the gradient is the conversion factor, f. Each figure corresponds to calibration at a time t_1, and illustrates two gradients. One gradient, f_a, corresponds to the best line fit to the high (4046 ppm) and low (1060 ppm) calibration gas points that also pass through the origin. The second gradient, f_b, corresponds to a line passing through both the origin and the low calibration gas. In some cases, the two lines are degenerate, and $f_a = f_b$.

Because most of the peak concentrations fall closer to 1060 ppm rather than 4046 ppm, the first order correction estimate for the conversion factor f_1 at time t_1 is taken to be

$$f_1 = f(t_1) = \frac{(f_a + f_b)}{2}$$

with uncertainty

$$\Delta f_1 = \frac{|f_a - f_b|}{2}$$

Likewise, there are values f_2 and Δf_2 at a later time t_2. The average value of conversion factor, f (which converts length of chart deflection to ppm), to be used for data recorded between time t_1 and time t_2 is

$$f_{avg} = \frac{f_1 + f_2}{2}$$

with attendant error

$$\Delta f_{avg} = \frac{[\Delta f_1^2 + \Delta f_2^2]^{1/2}}{2}$$

The above discussion assumes that the change in f and consequential difference between f_1 and f_2 are due to span and zero drifts.

2. Errors in Δy and Peak ppm Values

The peak ppm value for each Freon emission event is obtained from the corresponding chart deflection, Δy, as

$$E(ppm) = f_{avg}\Delta y$$

The fractional error in the ppm reading is

$$S_E = \frac{\Delta E}{E} = [S^2_{f_{avg}} + S^2_{\Delta y}]^{1/2}$$

where

$$S_{favg} = \frac{\Delta f_{avg}}{f} \text{ and } S_{\Delta y} = \frac{0.5}{\Delta y}$$

3. Errors in the Planimeter Reading for the Reference Rectangle

A reference rectangle was chosen for planimeter calibration. By knowing the area (planimeter reading) of the rectangle and the corresponding value of ppm-minutes (f_{avg} x area), one can convert any other area reading to ppm-minutes by a ratio factor. Accuracy and precision are required in determining the planimeter reading, P^*, for the reference rectangle.

To ensure an accurate reference area reading, 10 readings (q) were taken and averaged to determine P^*. Thus,

$$P^* = q_{avg} = \frac{\Sigma q}{10}$$

with uncertainty

$$\Delta P^* = \frac{S_q}{\sqrt{10}}$$

in which

$$S_q = \left[\frac{\Sigma(q-q_{avg})^2}{9}\right]^{1/2}$$

4. Errors in the Area Reading of Reference Rectangle

The number of ppm-minutes in the reference rectangle is

$$Z^* = f_{avg}A^* = f_{avg}y^*\Delta t^*$$

in which $A^* = y^*\Delta t^*$ is the area of the reference rectangle in cm-minutes. The uncertainty in this value is

$$S_{z^*} = \frac{\Delta Z^*}{Z} = [S^2_{f_{avg}} + S^2_{y^*} + S^2_{\Delta t}]^{1/2}$$

in which

$$S_{f_{avg}} = \frac{\Delta f_{avg}}{f_{avg}}$$

$$S_{y^*} = \frac{\Delta y^*}{y^*} = \frac{0.5}{y^*}$$

$$S_{\Delta t} \cong 3\%$$

5. Errors in the Planimeter Reading From Each Emission Event

A planimeter was used to obtain the area, Q_i, under each emission peak. Two readings, Q_{ia} and Q_{ib}, were obtained and averaged to obtain Q_i:

$$Q_i = \frac{Q_{ia} + Q_{ib}}{2}$$

$$\Delta Q_i = \frac{Q_{ia} - Q_{ib}}{2}$$

Each planimeter reading, Q_{ia} is converted into Z_i (ppm-minutes) by direct proportion with the reference rectangle planimeter reading:

$$Z_i = Z^* \frac{Q_i}{P^*}$$

in which Z^* is the number of ppm-minutes for the reference rectangle. The fractional error is given by

$$S^2_{Z_i} = [S^2_{Q_i} + S^2_{P*} + S^2_{Z*}]$$

in which

$$S_{Q_i} = \frac{\Delta Q_i}{Q_i}, \quad S_{P*} = \frac{\Delta P*}{P*}, \quad S_{Z*} = \frac{\Delta Z*}{Z*}$$

6. Overall Measurement Error for Each Site

The overall emission integral for a particular site was obtained by summing the individual integrals (Z_i) for all N emission events:

$$Z_{tot} = \sum_{i=1}^{N} Z_i$$

The absolute error, $S_{Z_{tot}}$, in Z_{tot} is given in terms of the absolute error S_{Z_i} in Z_i by

$$S_{Z_{tot}}(\text{ppm-minutes}) = [\sum_{i=1}^{N} S_{Z_i}^2]^{1/2}$$

The error analysis is summarized in Tables B-1 through B-10. From the data given in these tables, it can be seen that results from 7 of the 10 sites tested have percent errors of less than 5. Two of the 10 sites have percent errors of less than 7, and one site (Site 3) has an error of approximately 10 percent. Site 3 has a higher percent error due to the drift problems that occurred.

D. ERRORS IN AIR FLOW RATE MEASUREMENTS

The quantity of Freon emitted annually is dependent on both the Freon concentration in the emitted gas and the flow rate through the exhaust duct. EPA Method 2 was used to determine air flow rates in the exhaust ducts selected for study. Errors in Freon emissions calculations due to variations in flow rate measurements approximate those described above. The percent variations in air flow rates presented in Table 11 range from 3 to 7 percent.

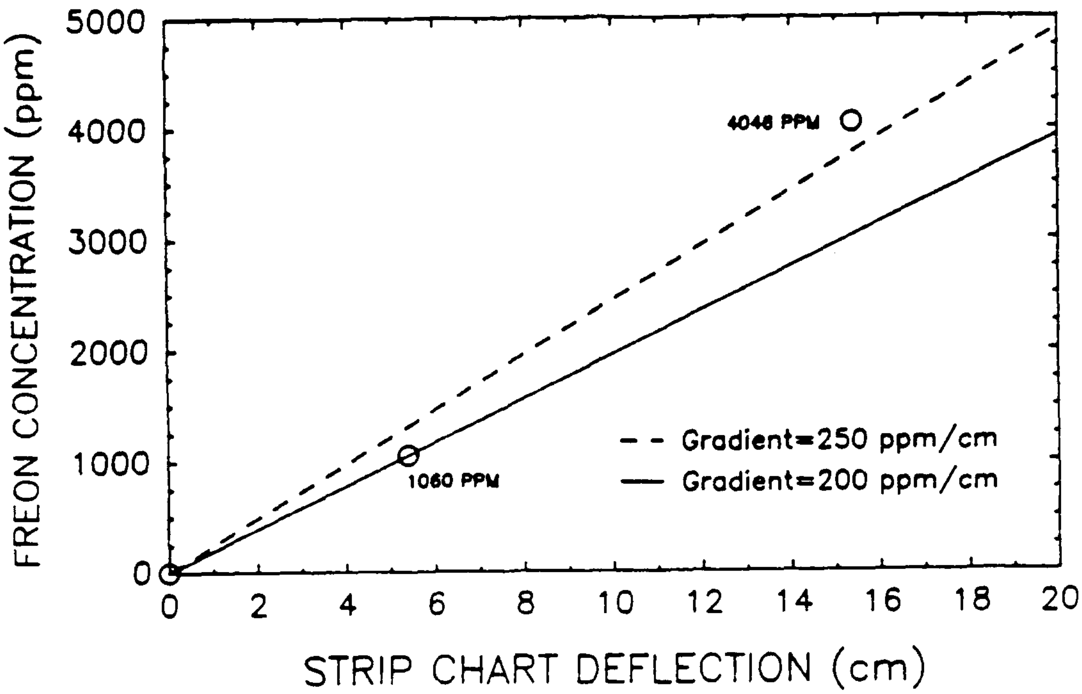

Figure B-1. Results of Calibration 1 at Site 1.

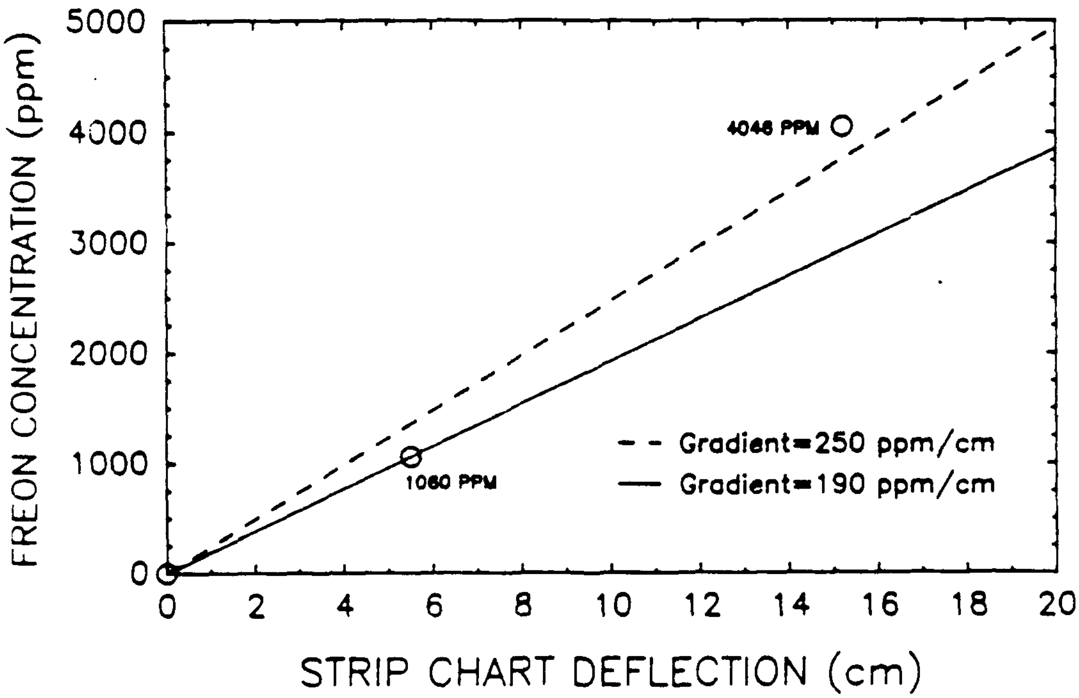

Figure B-2. Results of Calibration 2 at Site 1.

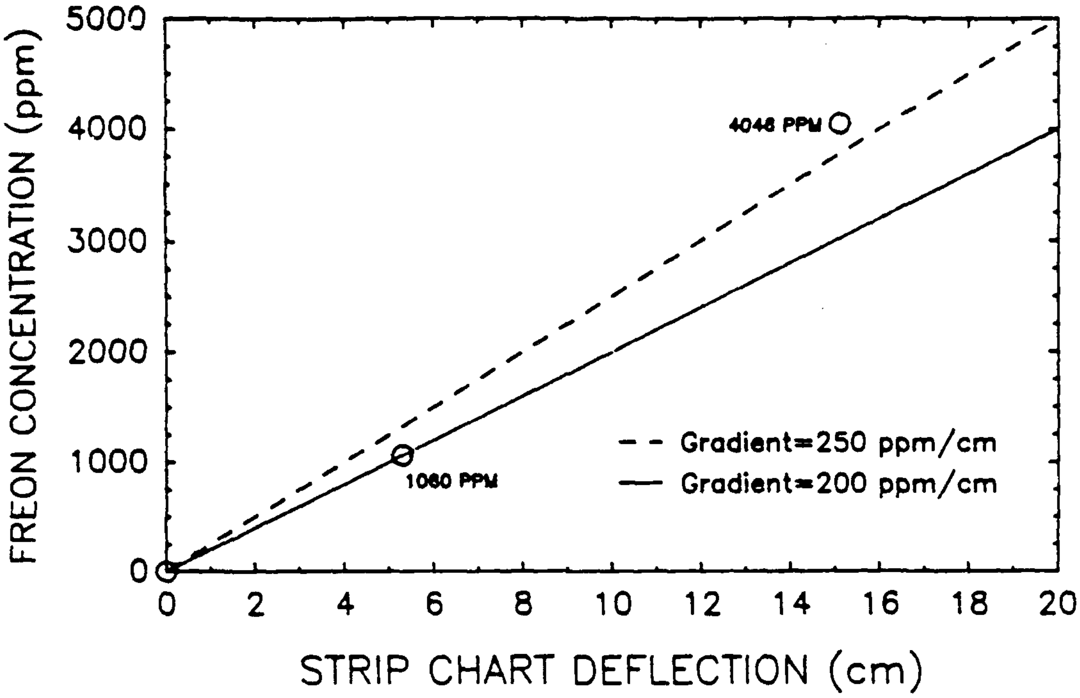

Figure B-3. Results of Calibration 3 at Site 1.

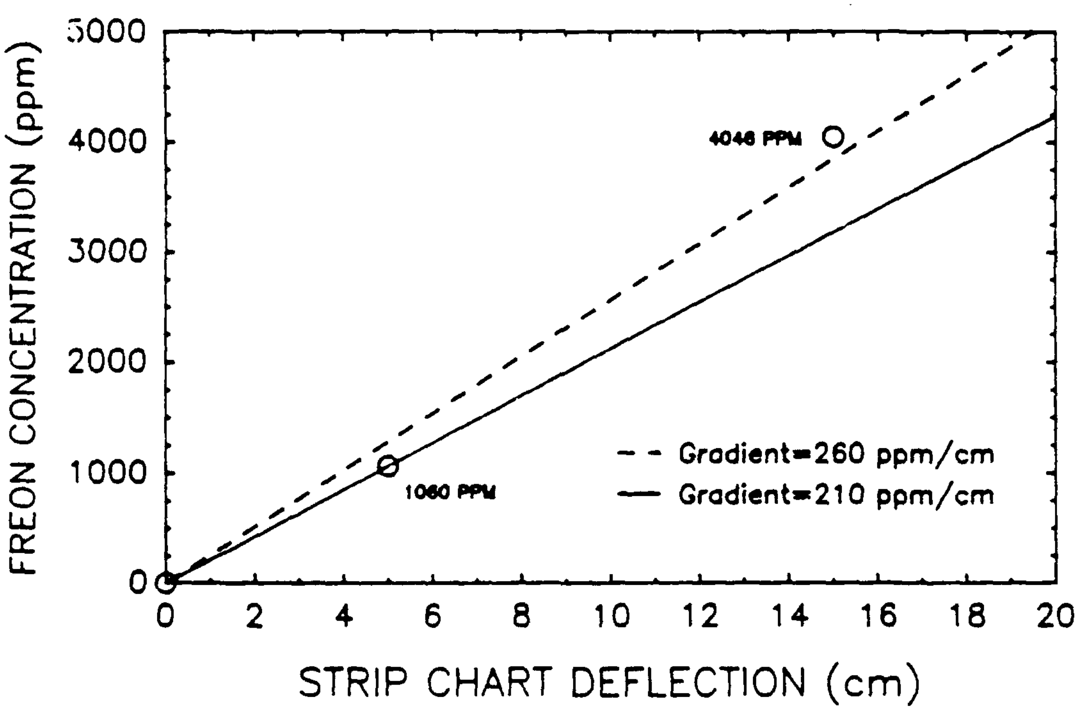

Figure B-4. Results of Calibration 4 at Site 1.

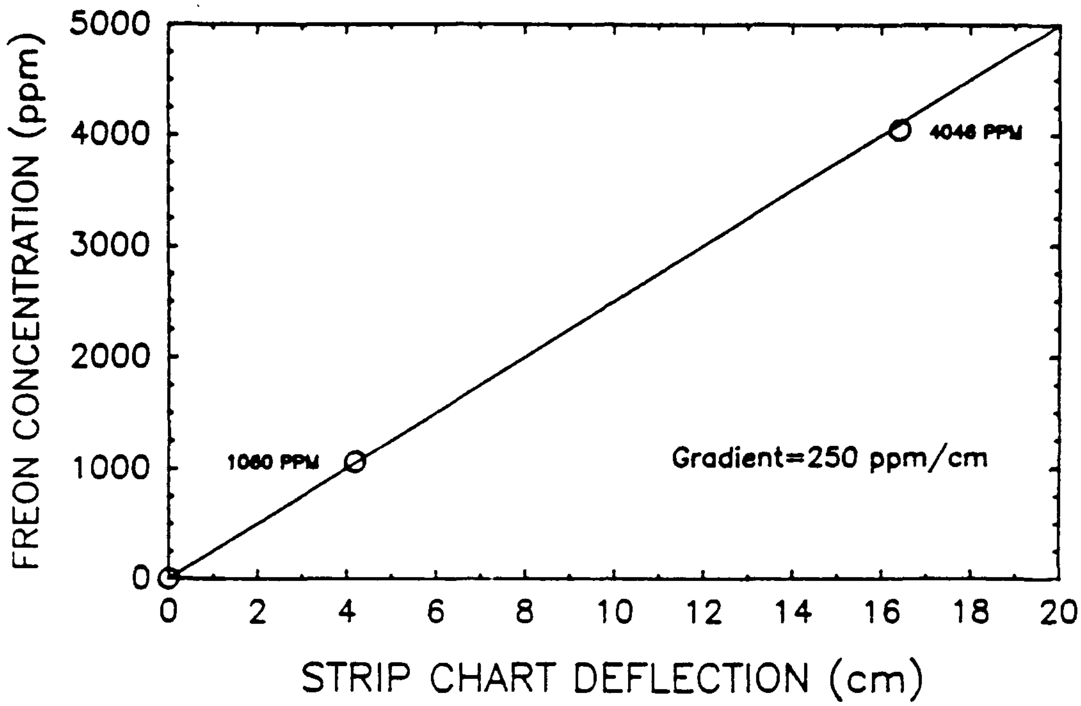

Figure B-5. Results of Calibration 1 at Site 2.

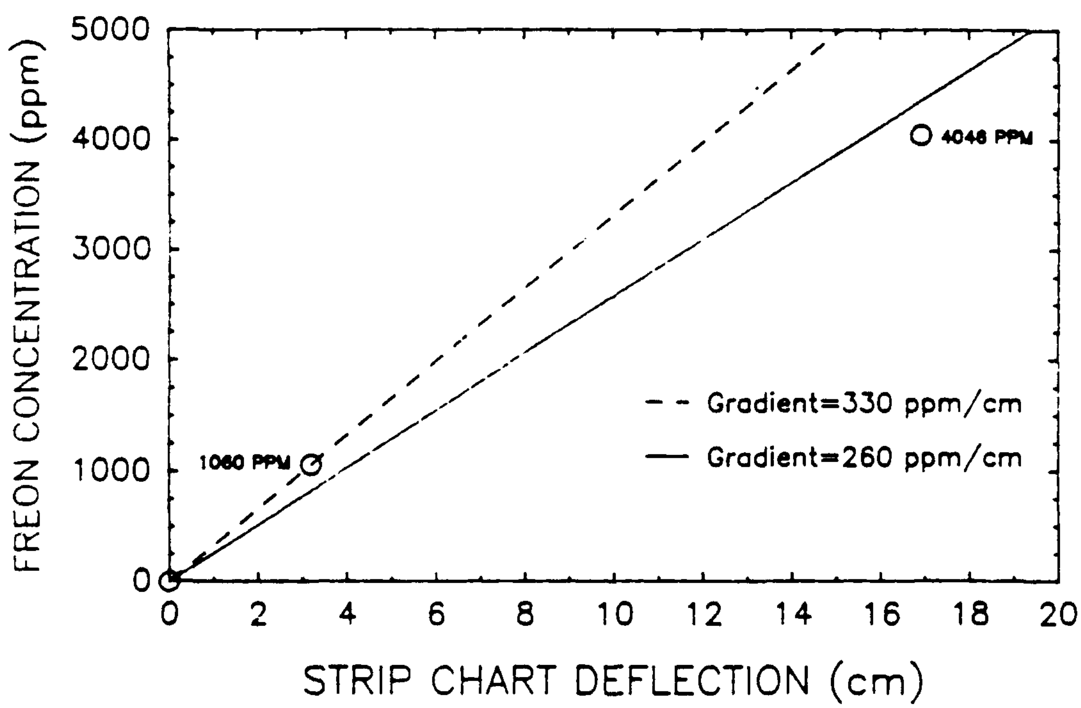

Figure B-6. Results of Calibration 2 at Site 2.

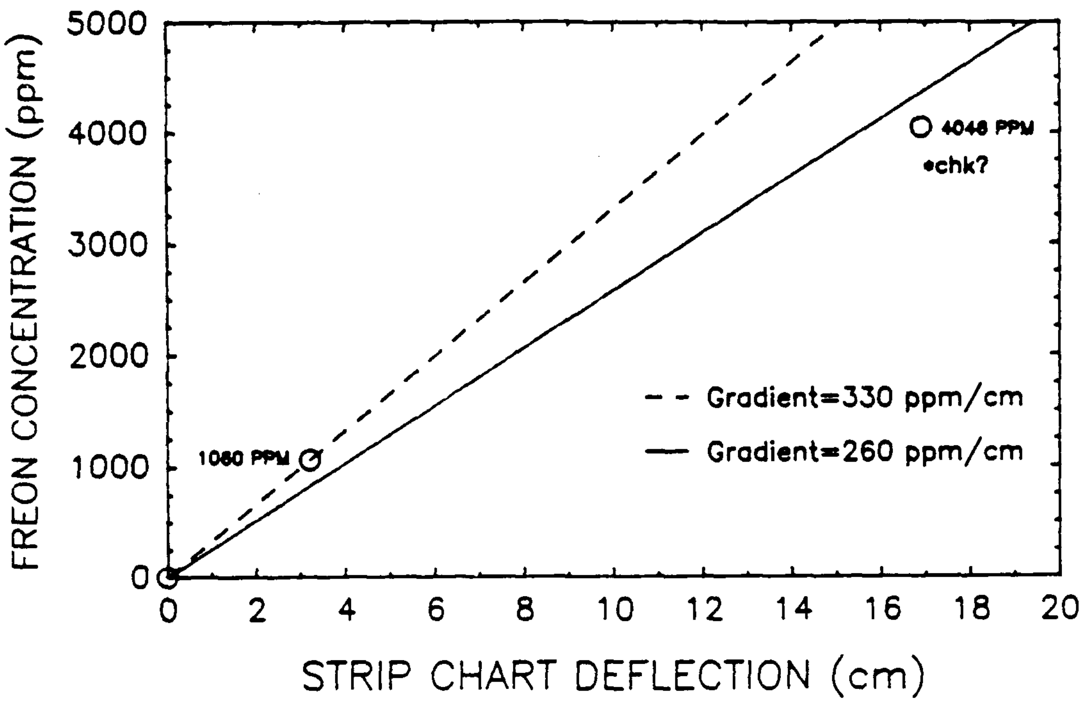

Figure B-7. Results of Calibration 3 at Site 2.

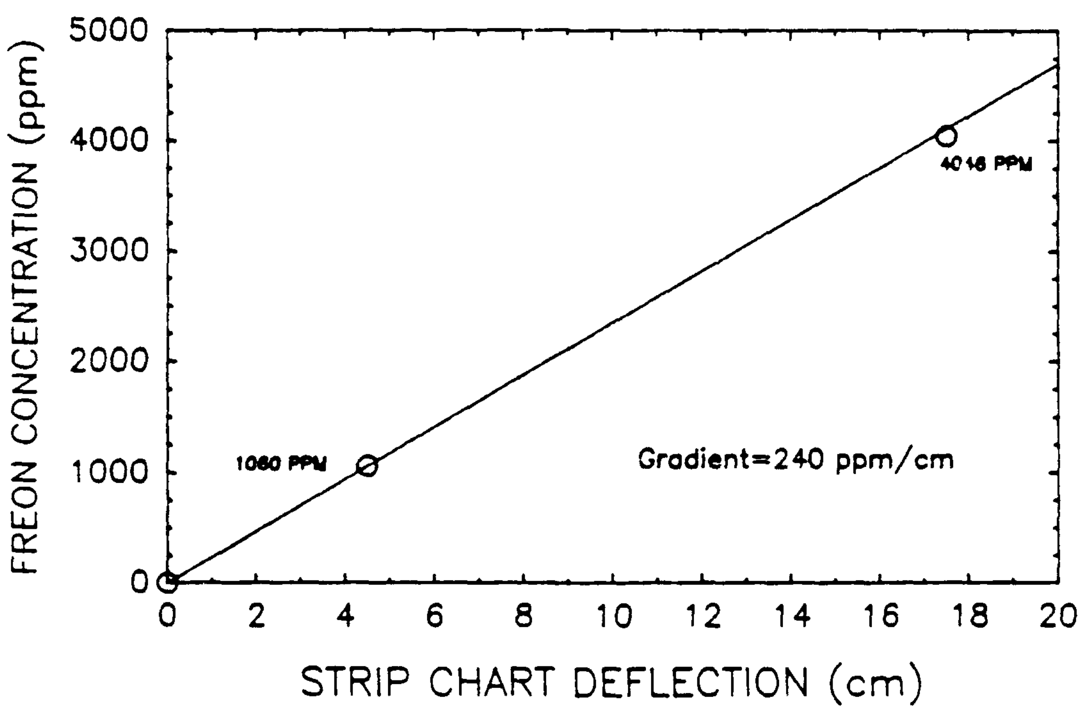

Figure B-8. Results of Calibration 4 at Site 2.

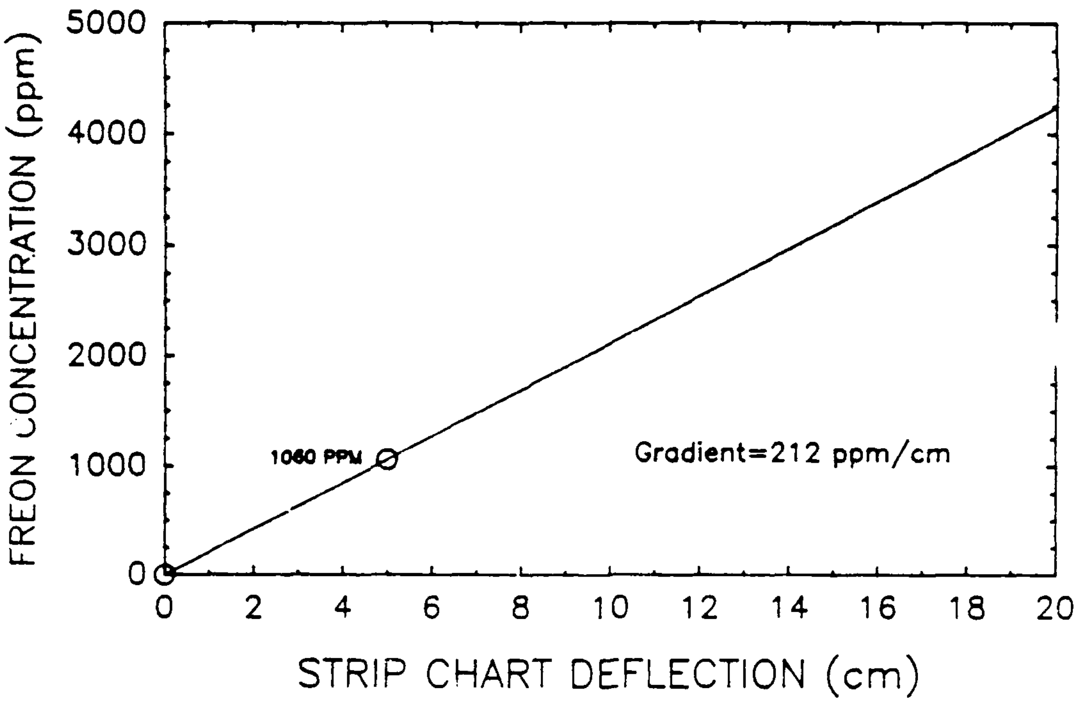

Figure B-9. Results of Calibration 5 at Site 2.

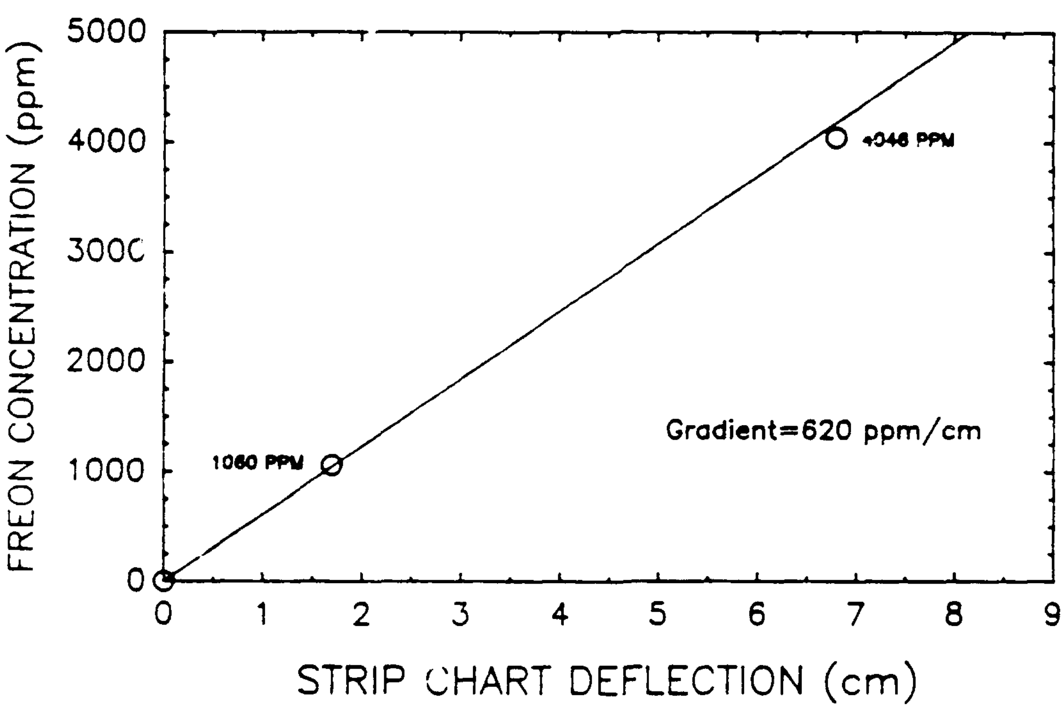

Figure B-10. Results of Calibration 1 at Site 3.

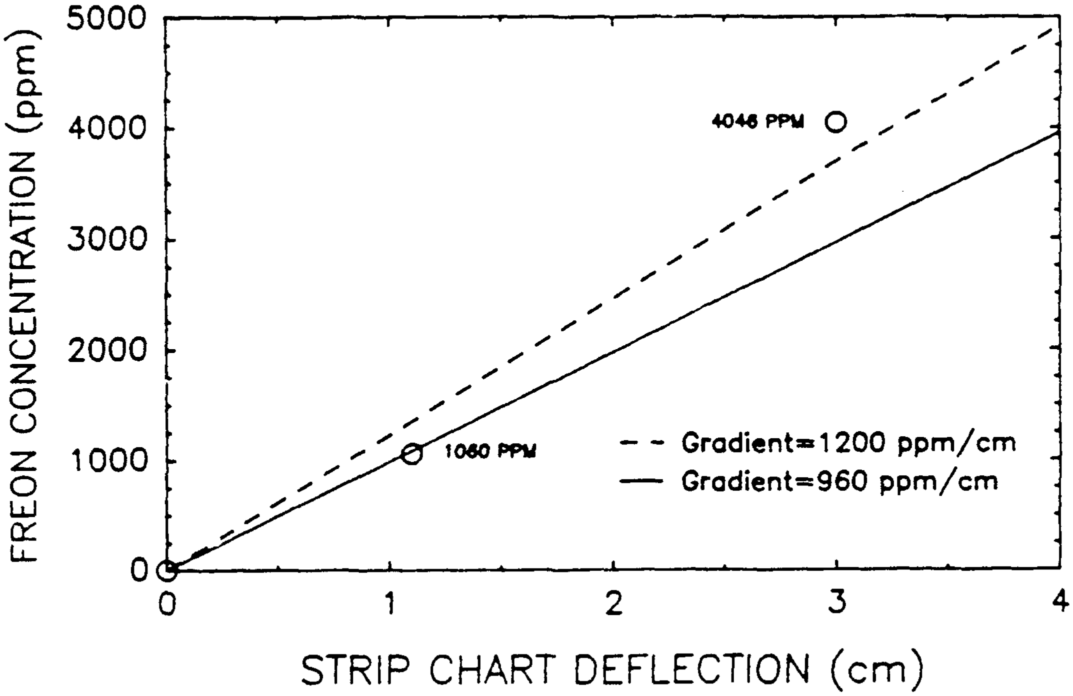

Figure B-11. Results of Calibration 2 at Site 3.

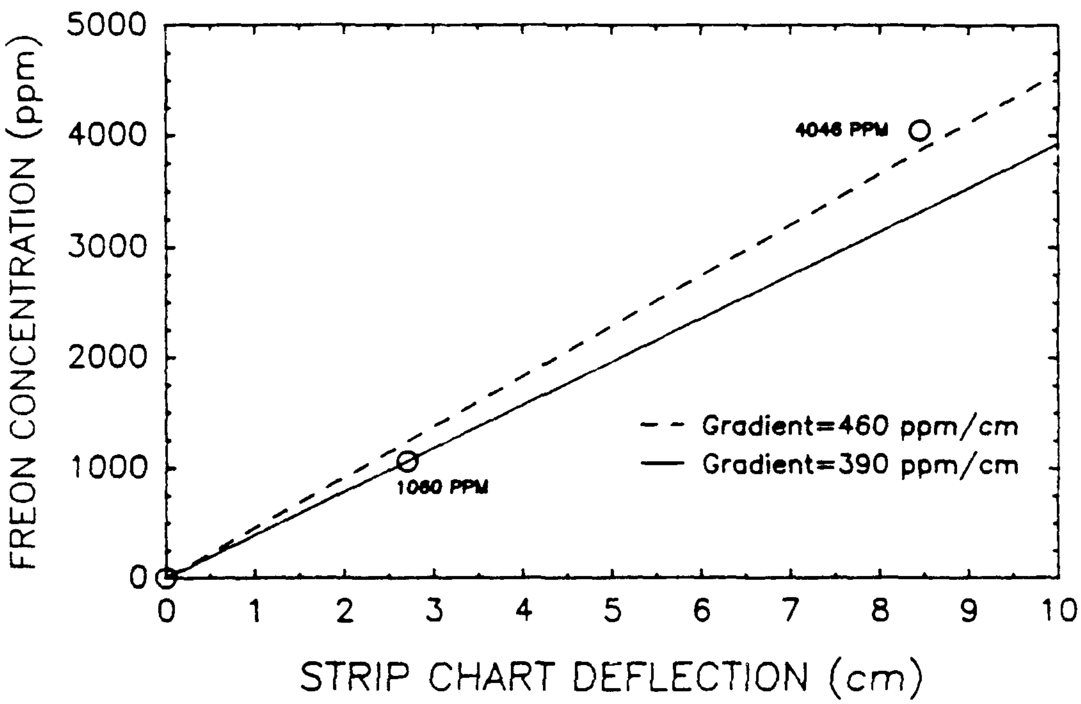

Figure B-12. Results of Calibration 1 at Site 4.

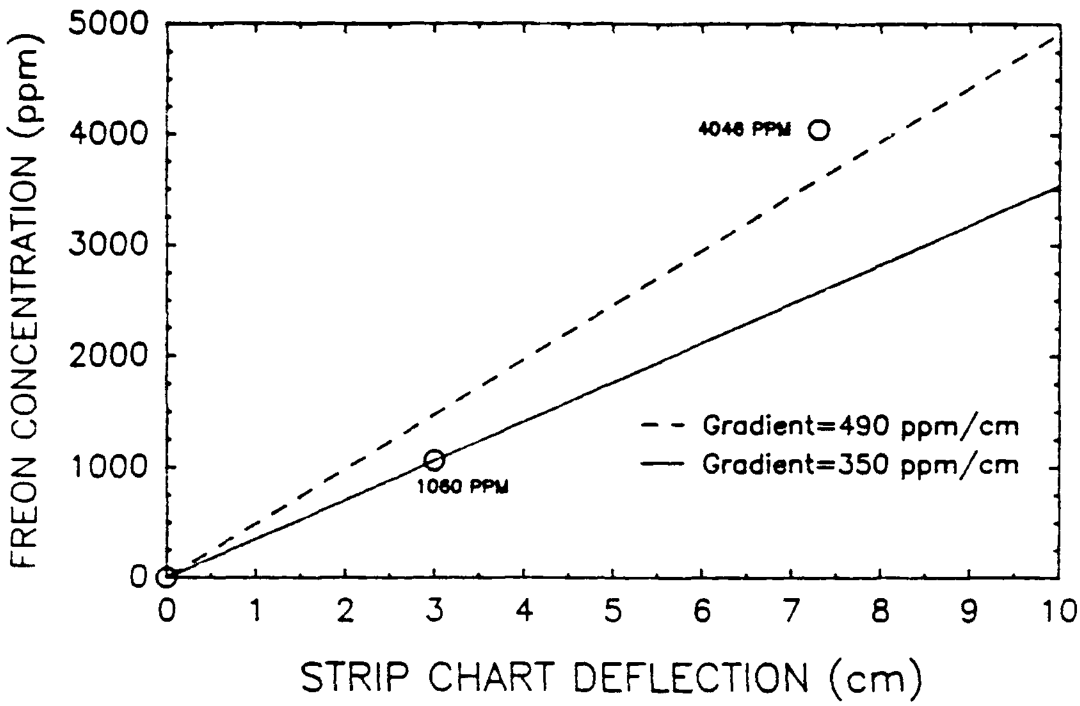

Figure B-13. Results of Calibration 2 at Site 4.

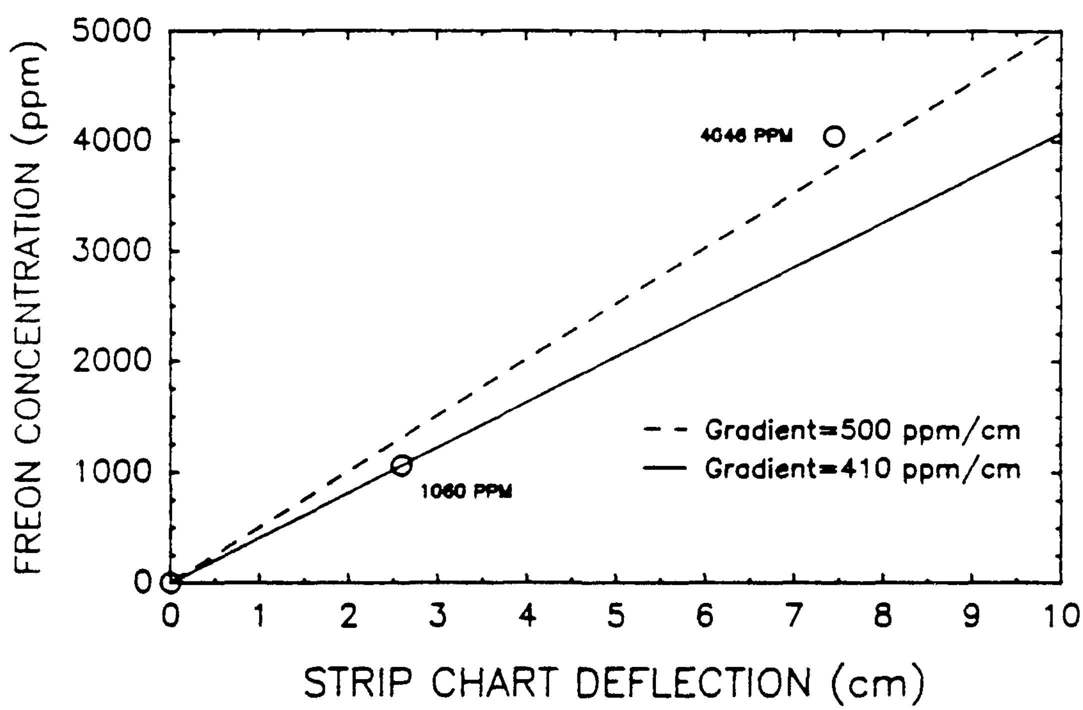

Figure B-14. Results of Calibration 3 at Site 4.

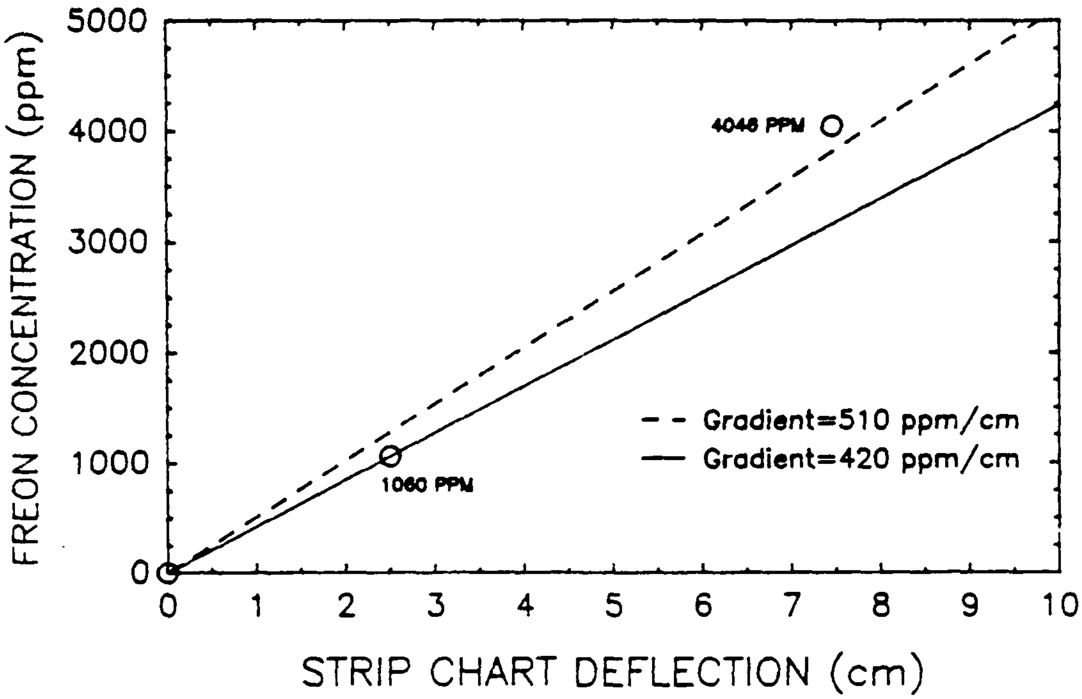

Figure B-15. Results of Calibration 4 at Site 4.

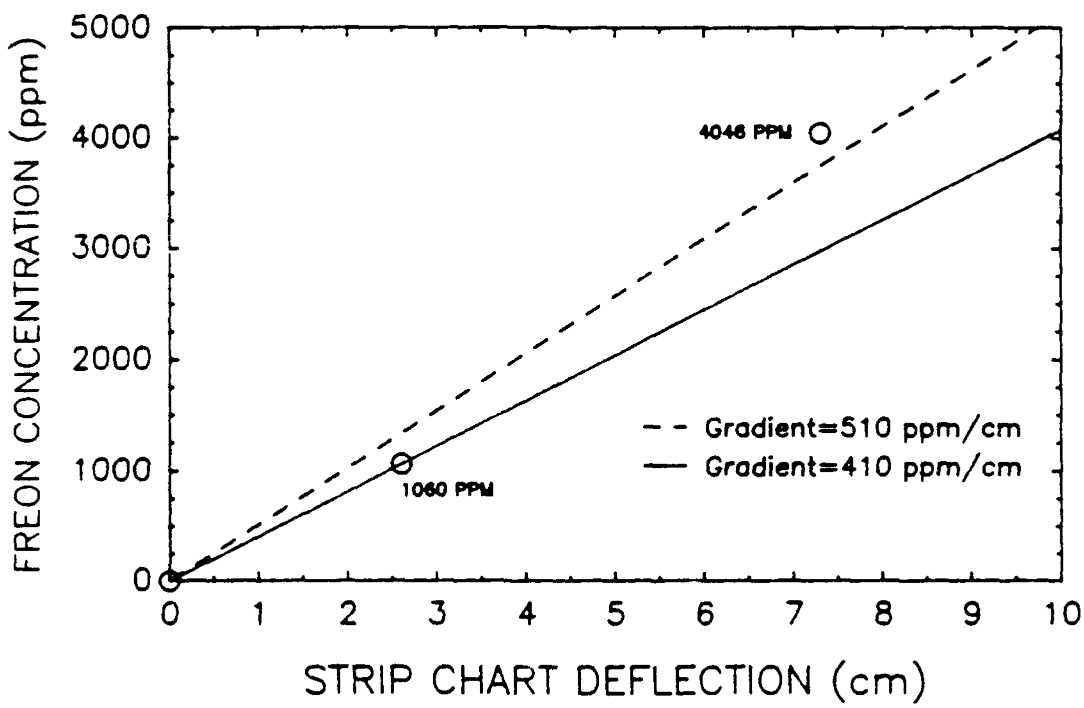

Figure B-16. Results of Calibration 1 at Site 5.

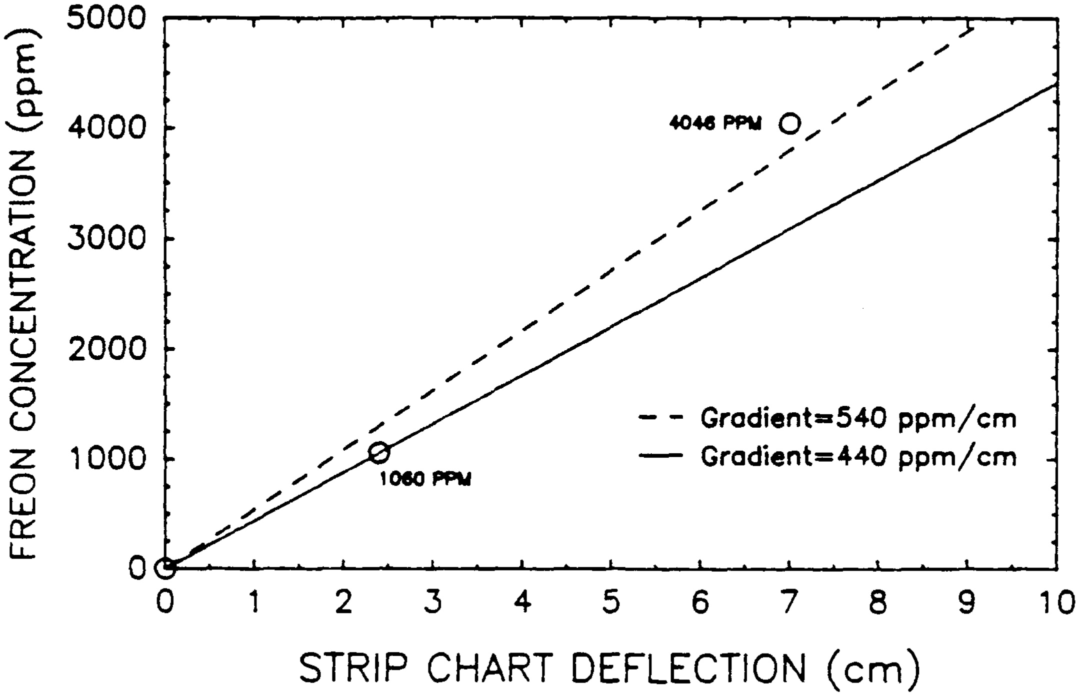

Figure B-17. Results of Calibration 2 at Site 5.

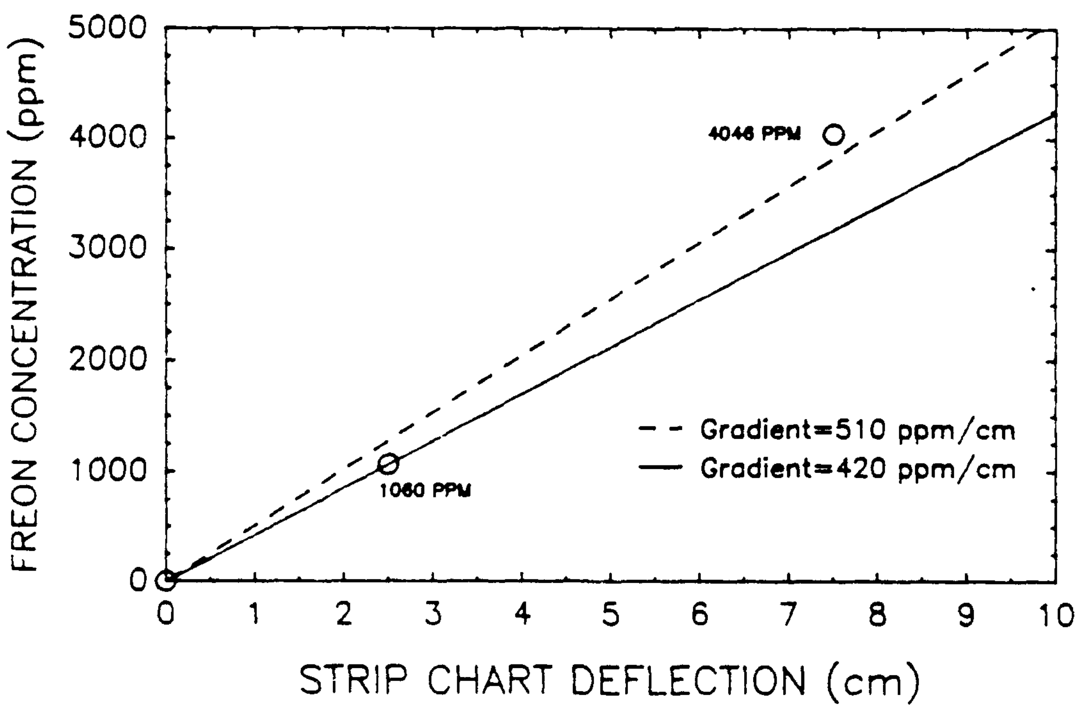

Figure B-18. Results of Calibration 3 at Site 5.

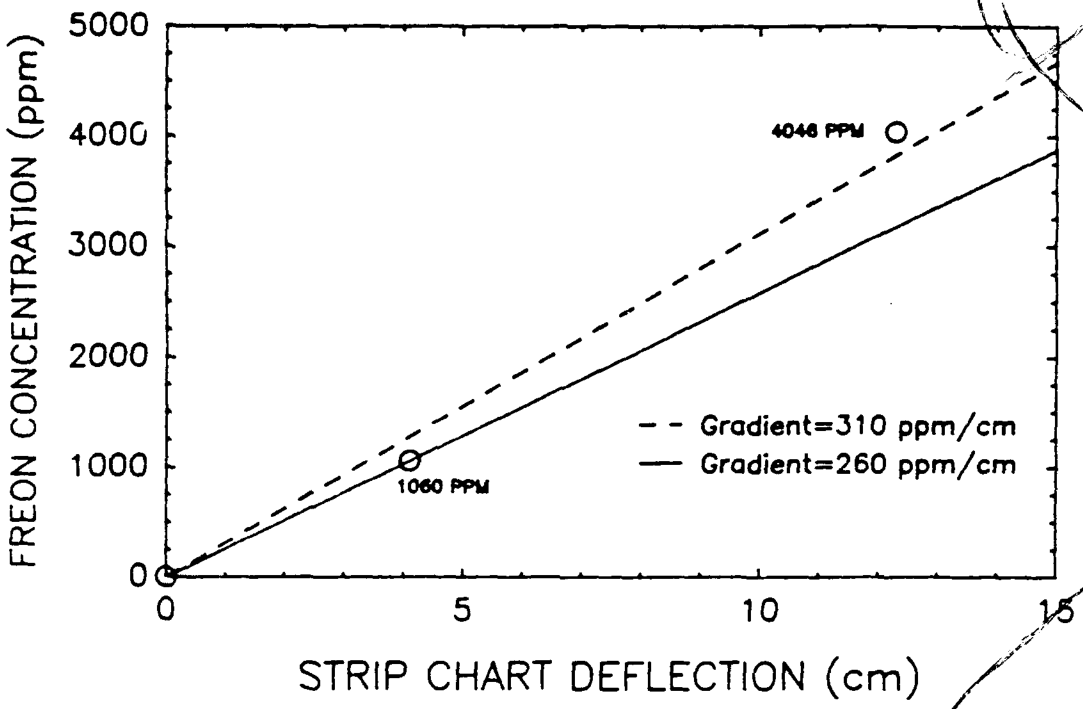

Figure B-19. Results of Calibration 1 at Site 6.

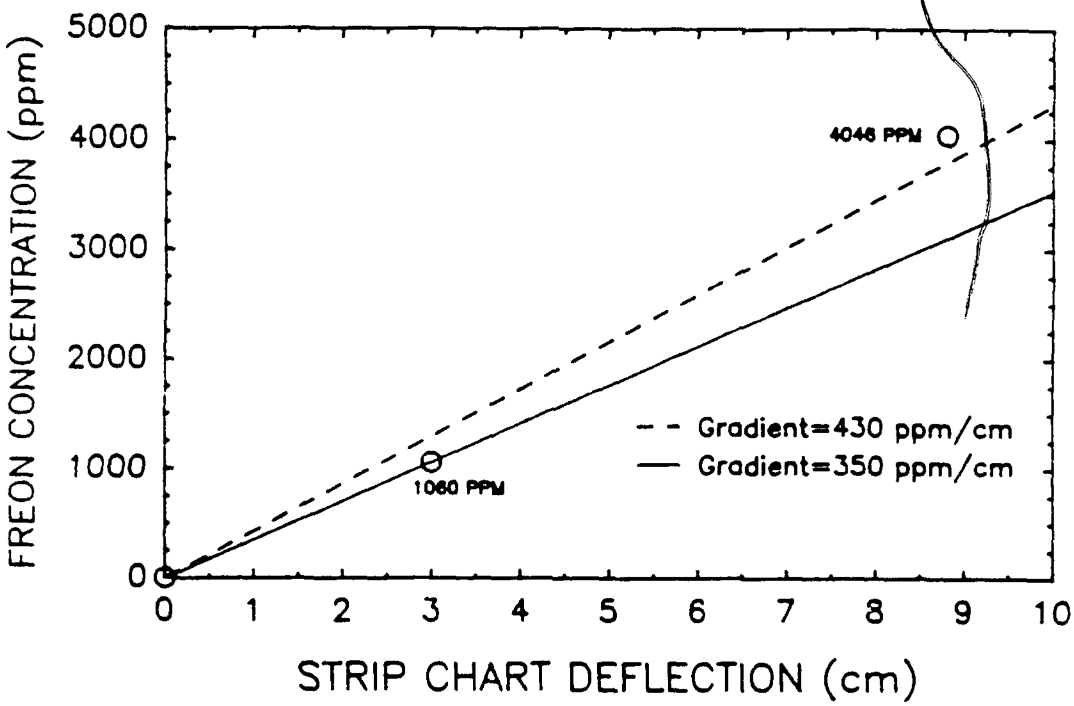

Figure B-20. Results of Calibration 2 at Site 6.

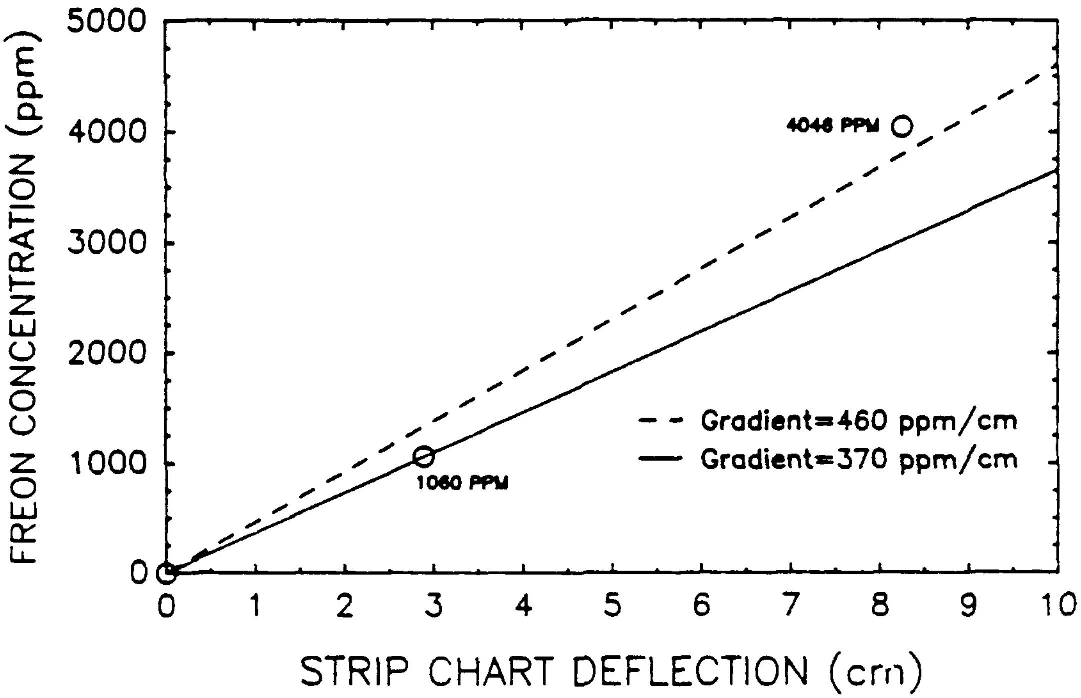

Figure B-21. Results of Calibration 3 at Site 6.

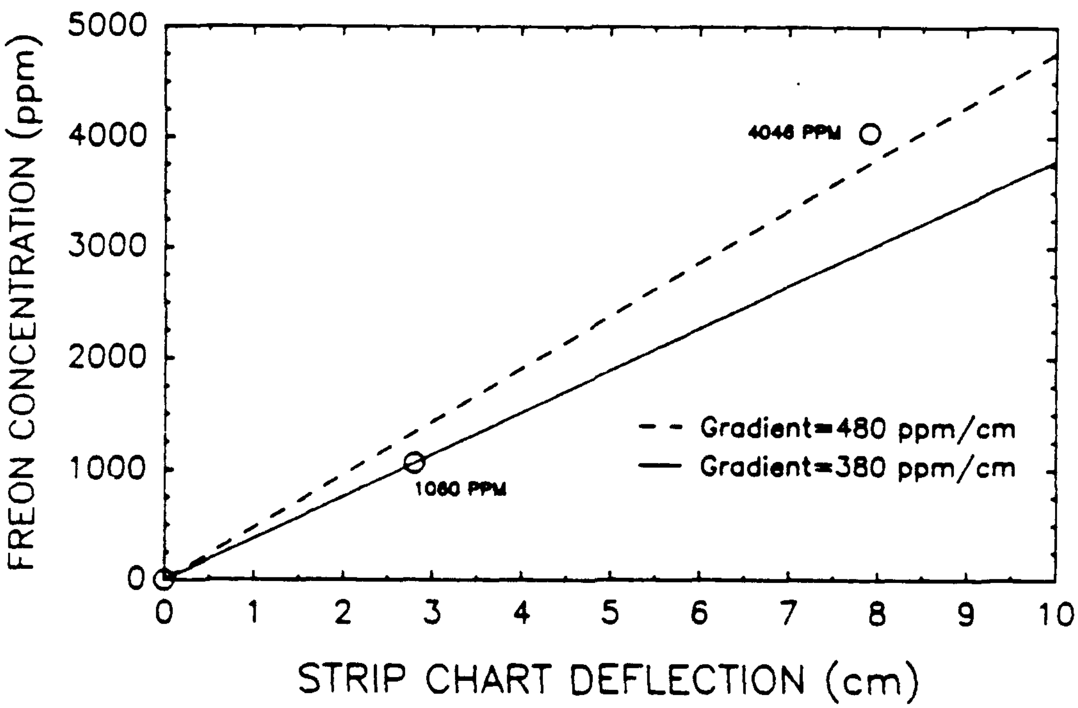

Figure B-22. Results of Calibration 4 at Site 6.

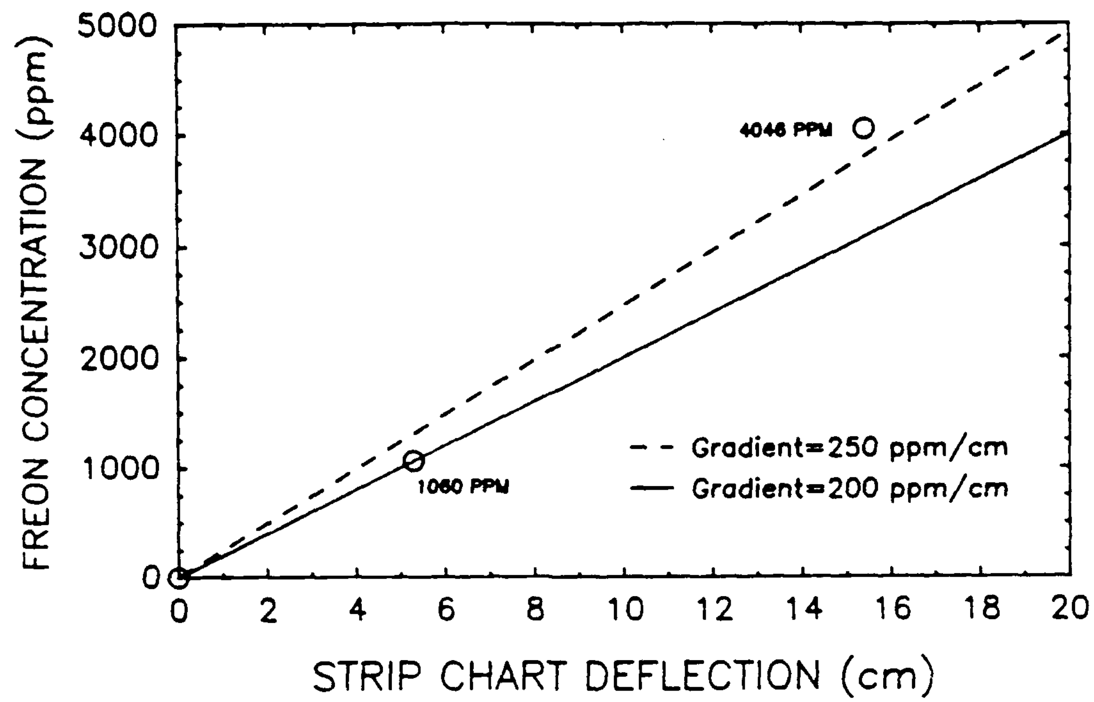

Figure B-23. Results of Calibration 1 at Site 7.

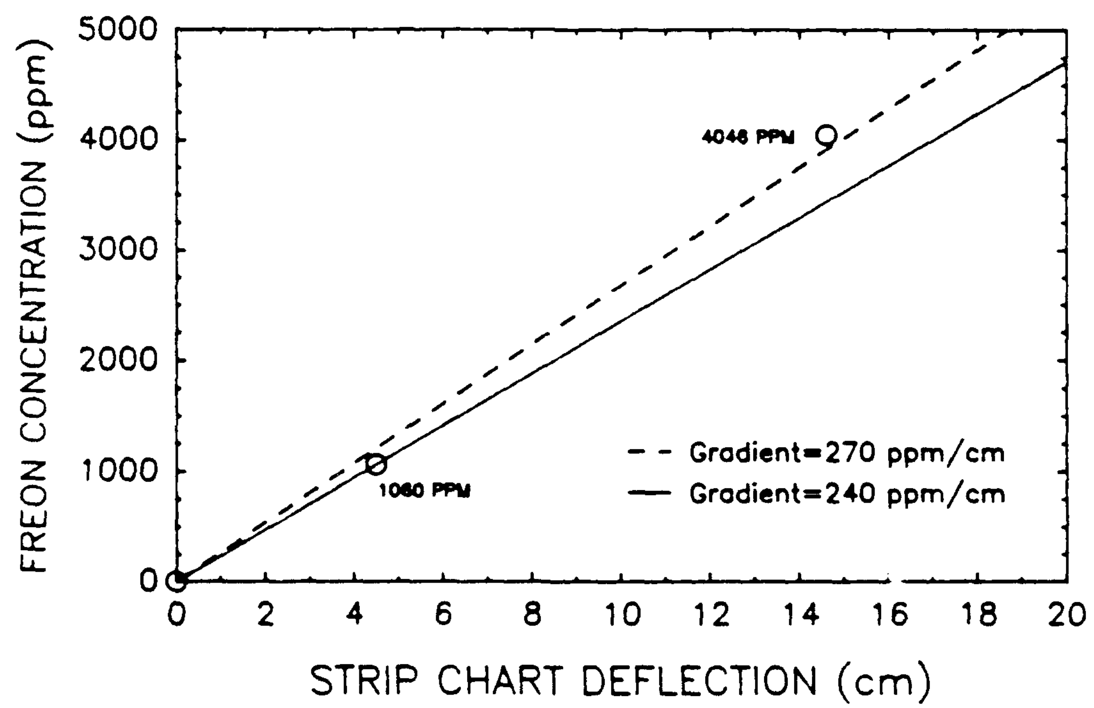

Figure B-24. Results of Calibration 2 at Site 7.

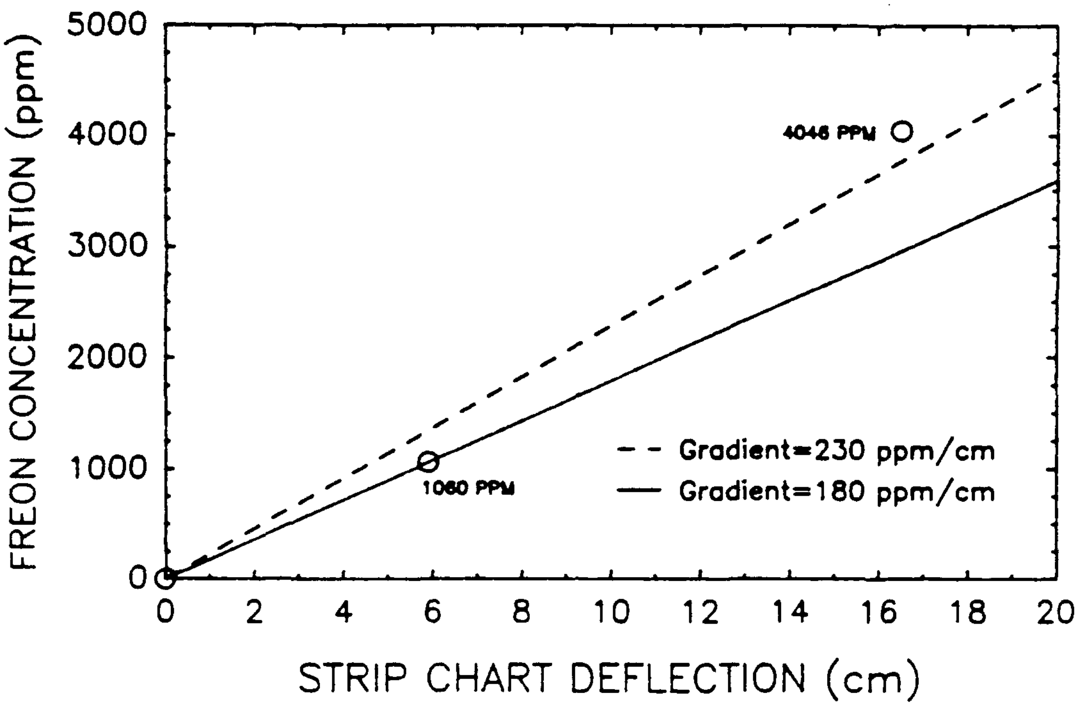

Figure B-25. Results of Calibration 3 at Site 7.

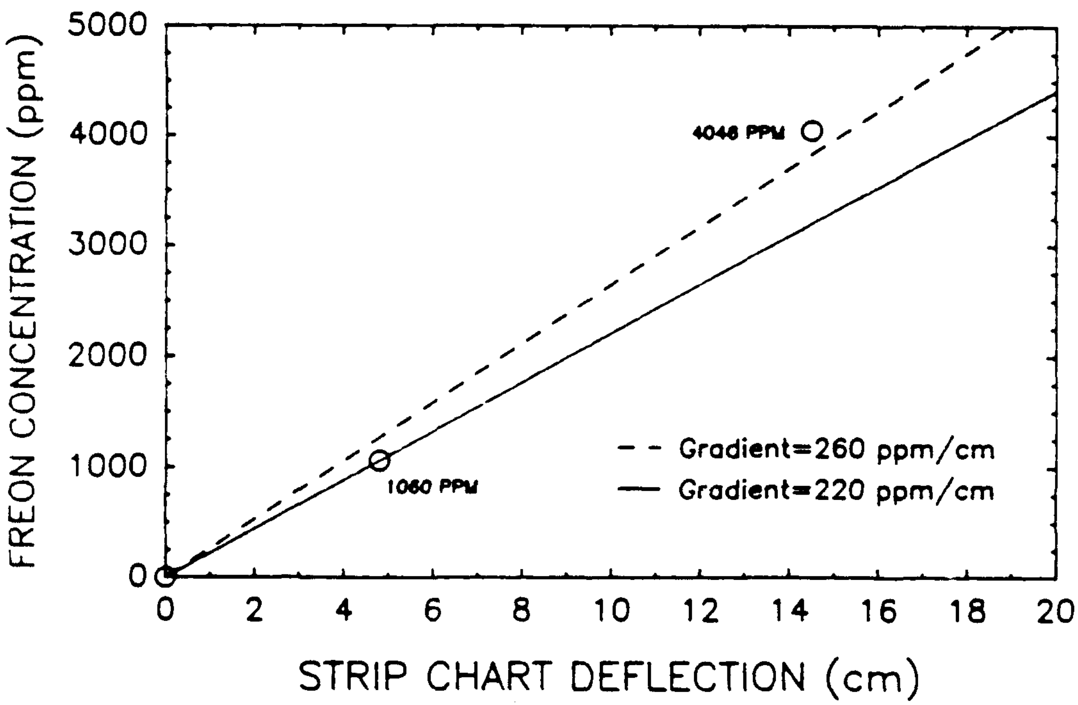

Figure B-26. Results of Calibration 4 at Site 7.

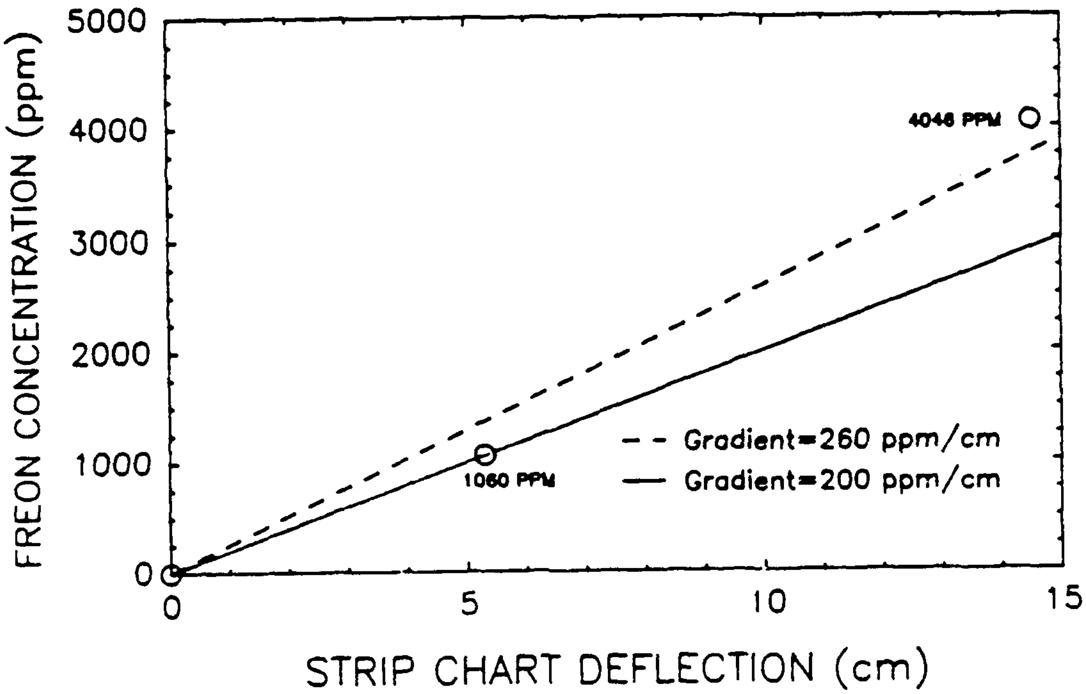

Figure B-27. Results of Calibration 1 at Site 8.

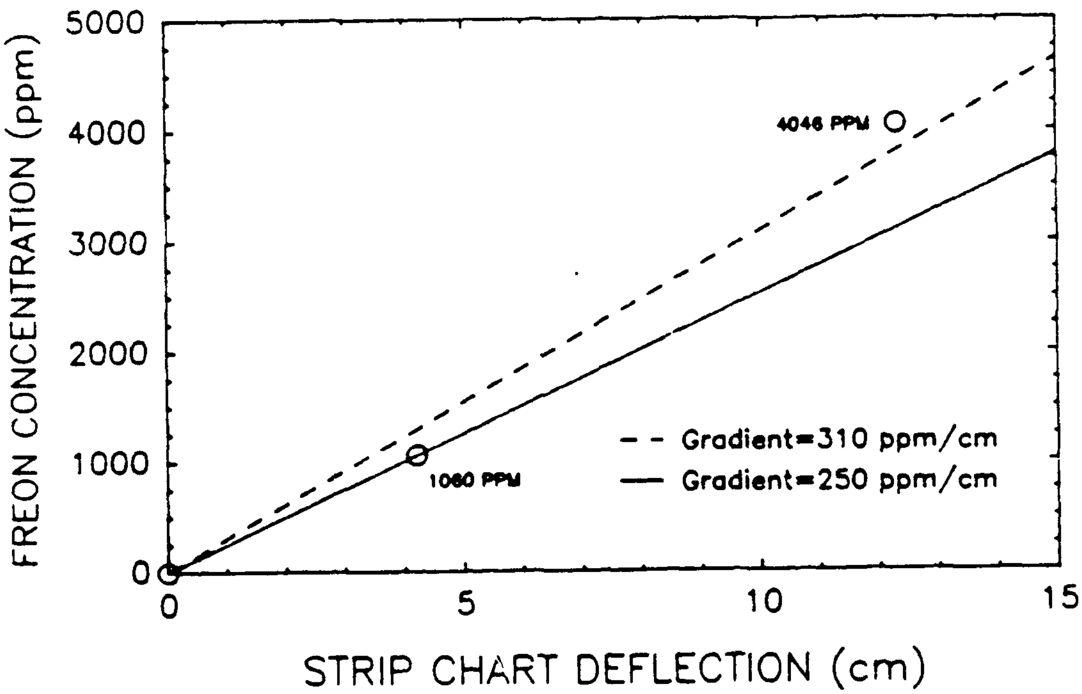

Figure B-28. Results of Calibration 2 at Site 8.

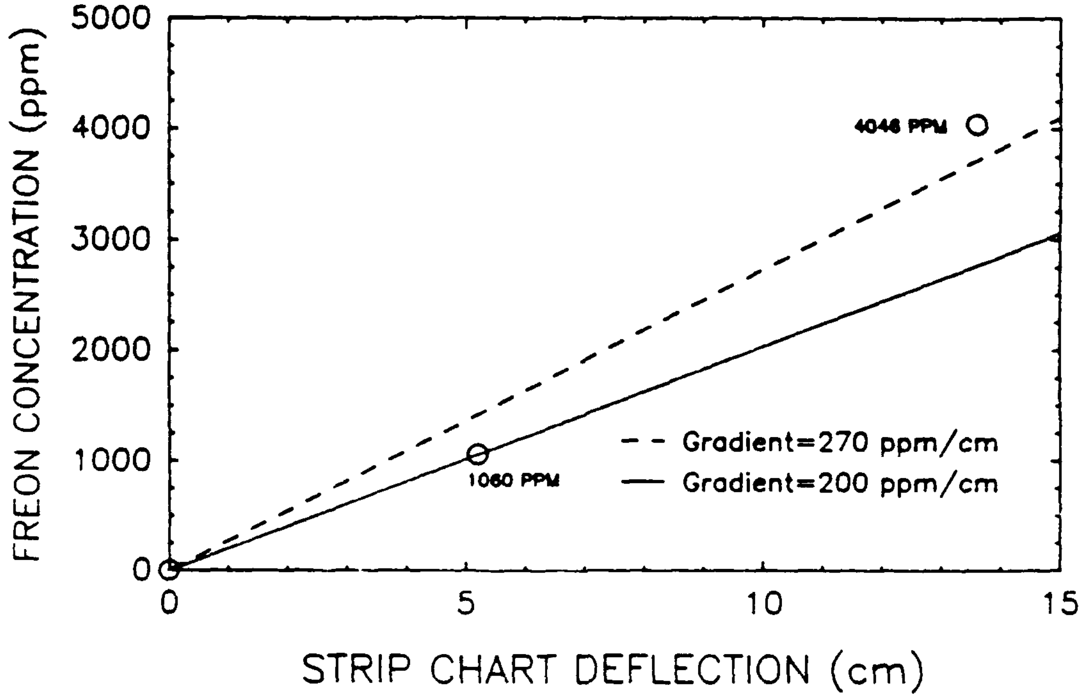

Figure B-29. Results of Calibration 3 at Site 8.

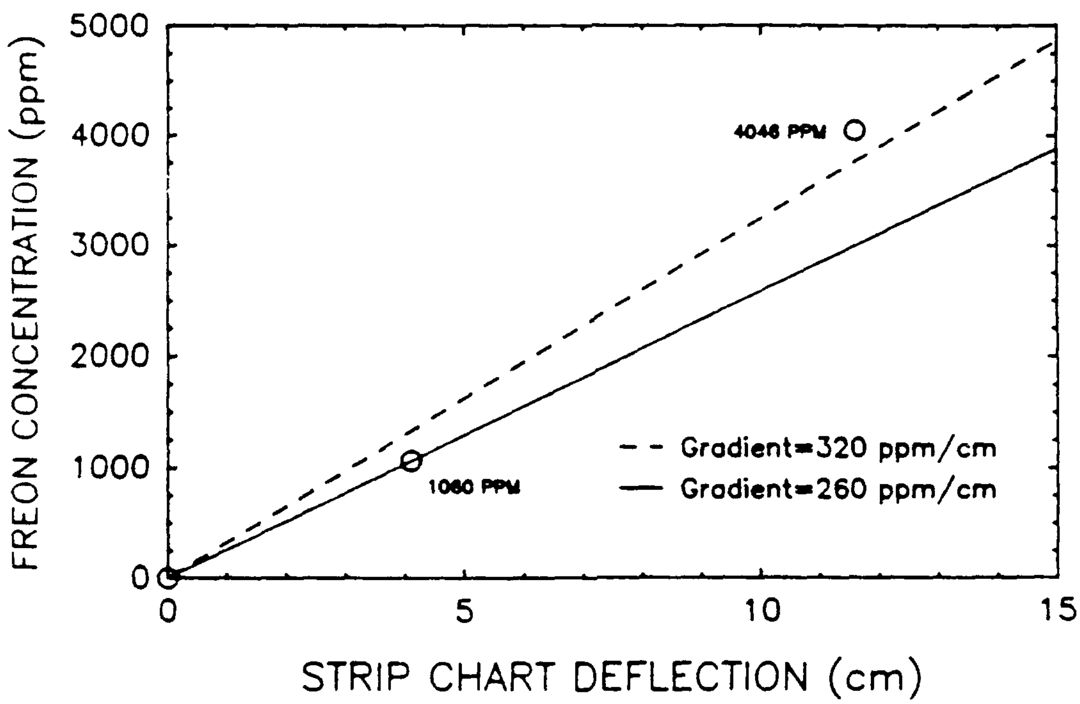

Figure B-30. Results of Calibration 4 at Site 8.

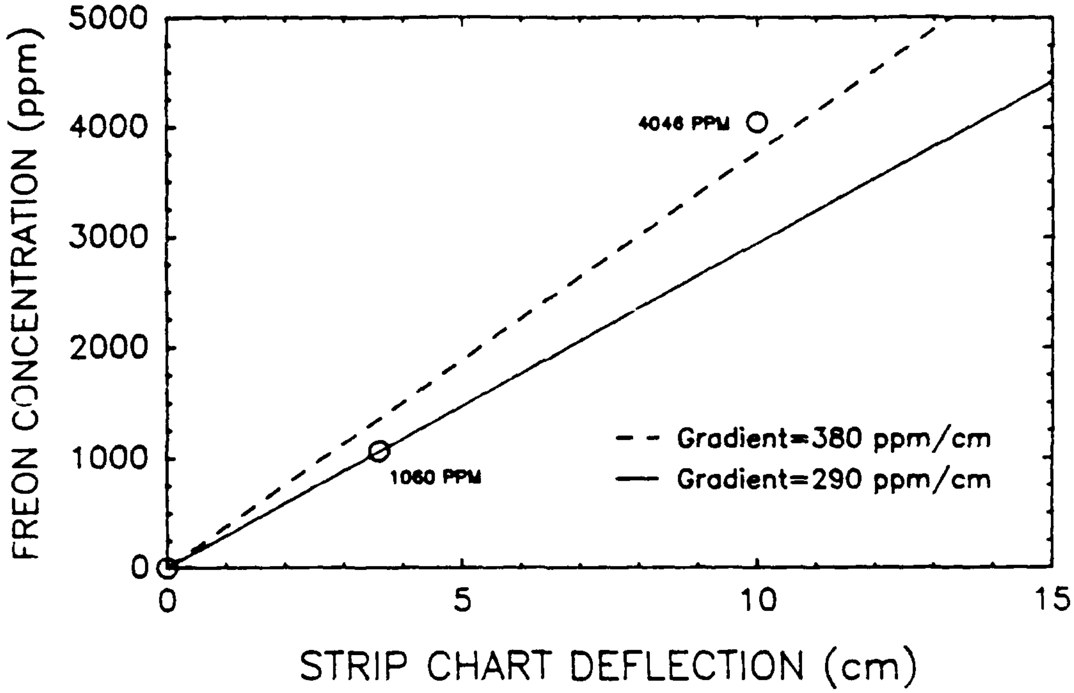

Figure B-31. Results of Calibration 5 at Site 8.

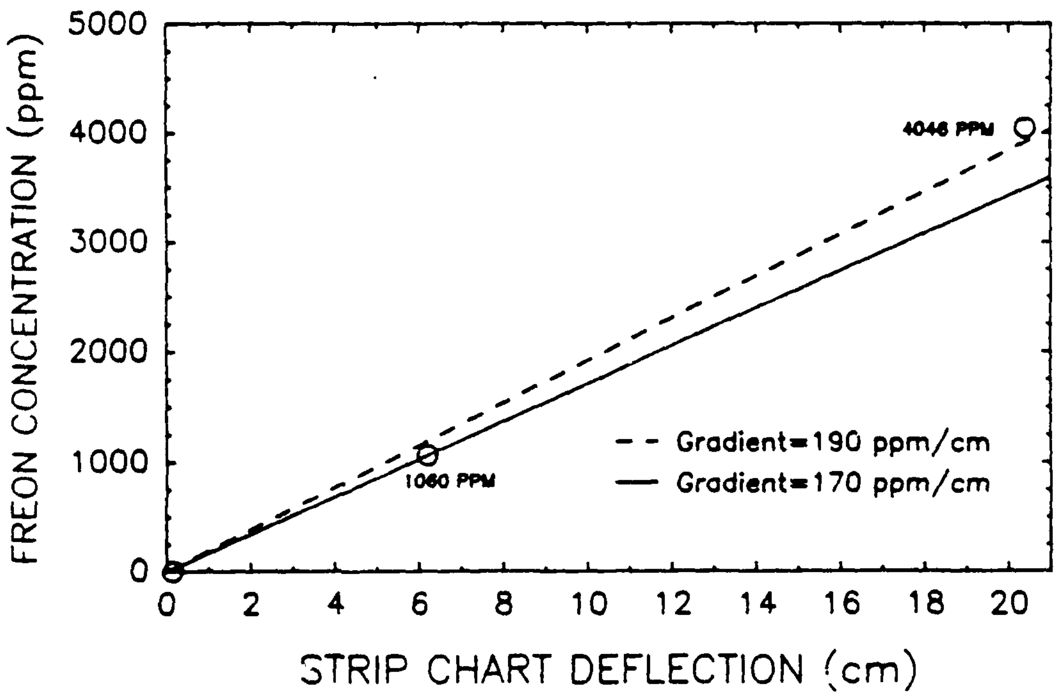

Figure B-32. Results of Calibration 1 of CA 3.

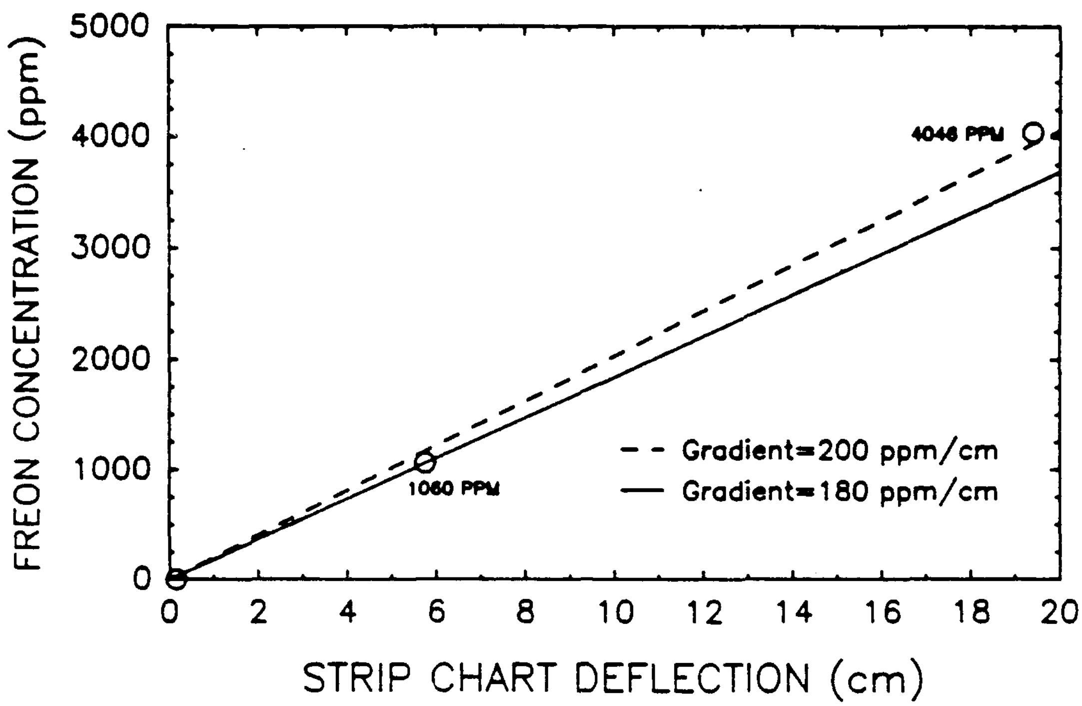

Figure B-33. Results of Calibration 2 of CA 3.

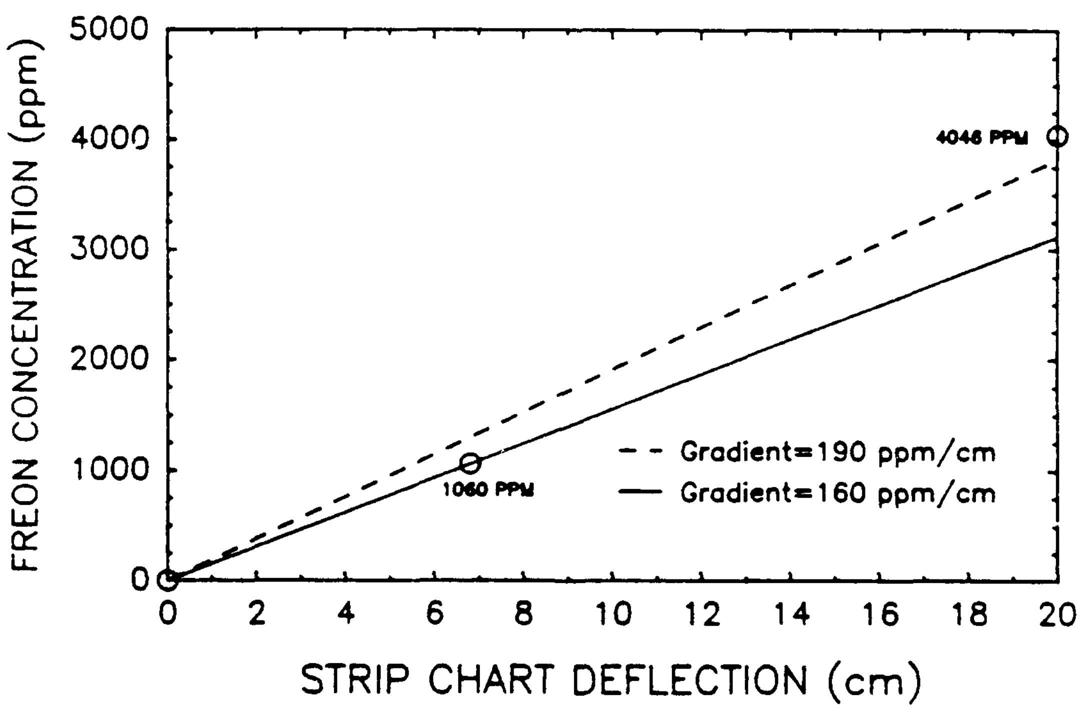

Figure B-34. Results of Calibrations 3 and 4 of CA 3.

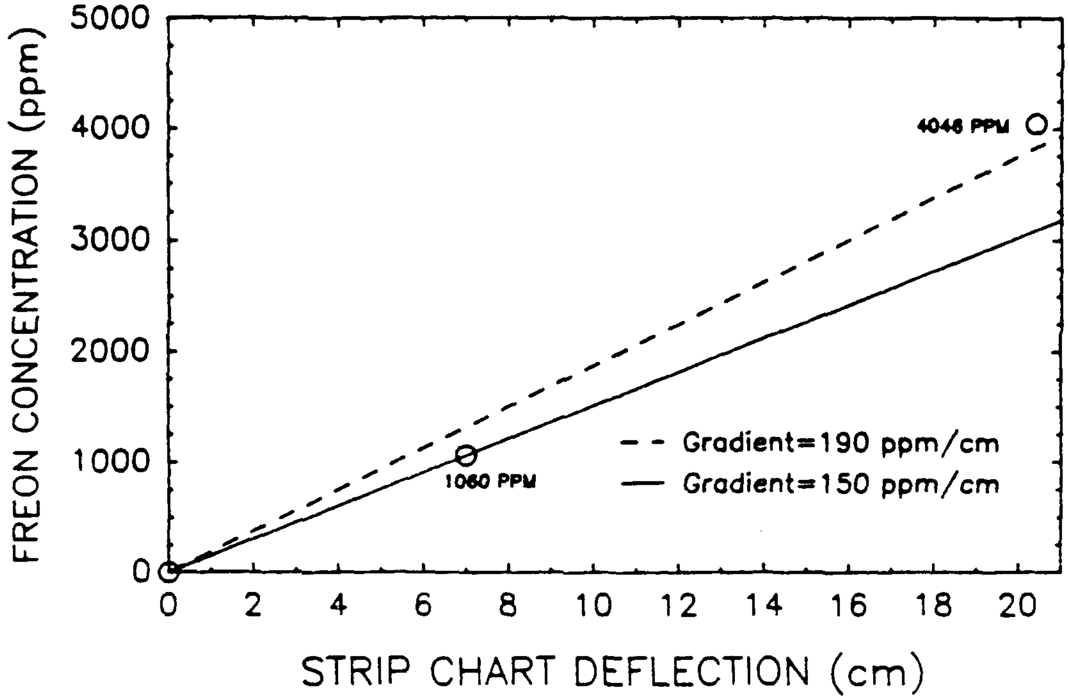

Figure B-35. Results of Calibration 5 of CA 3.

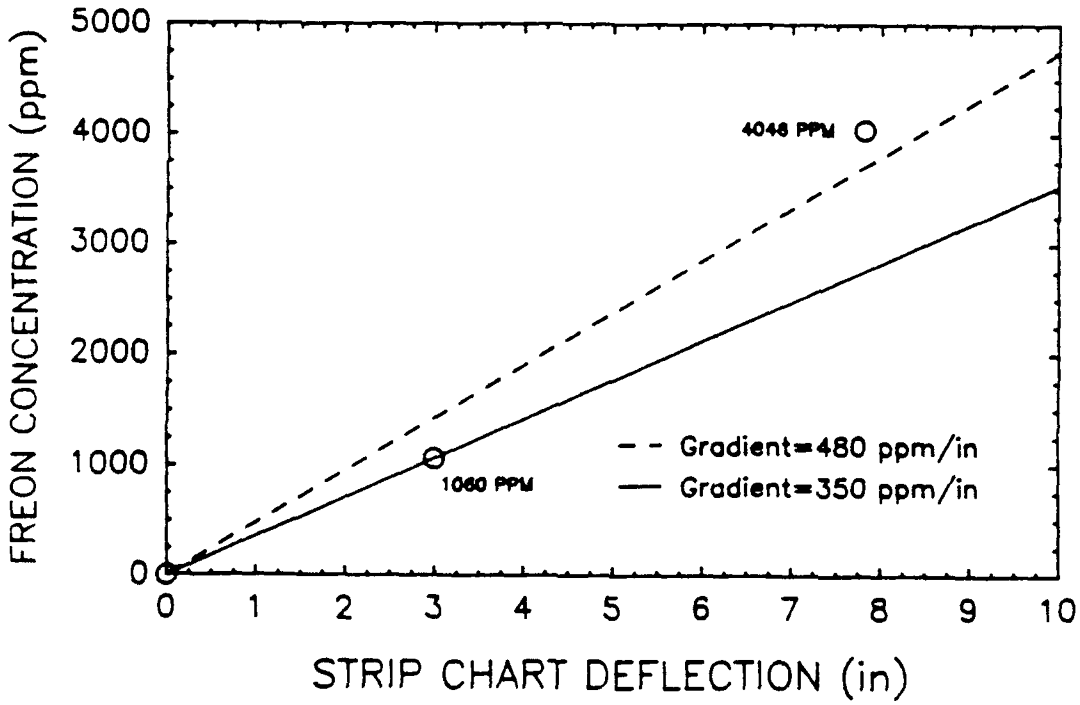

Figure B-36. Results of Calibration 1 of CA 4.

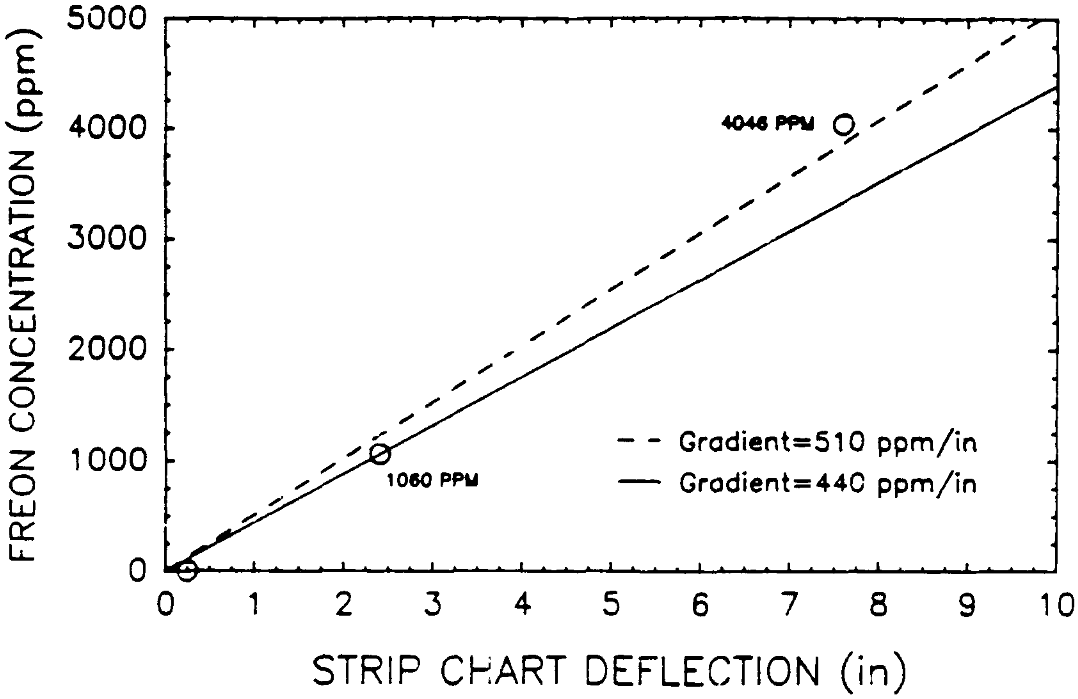

Figure B-37. Results of Calibration 2 of CA 4.

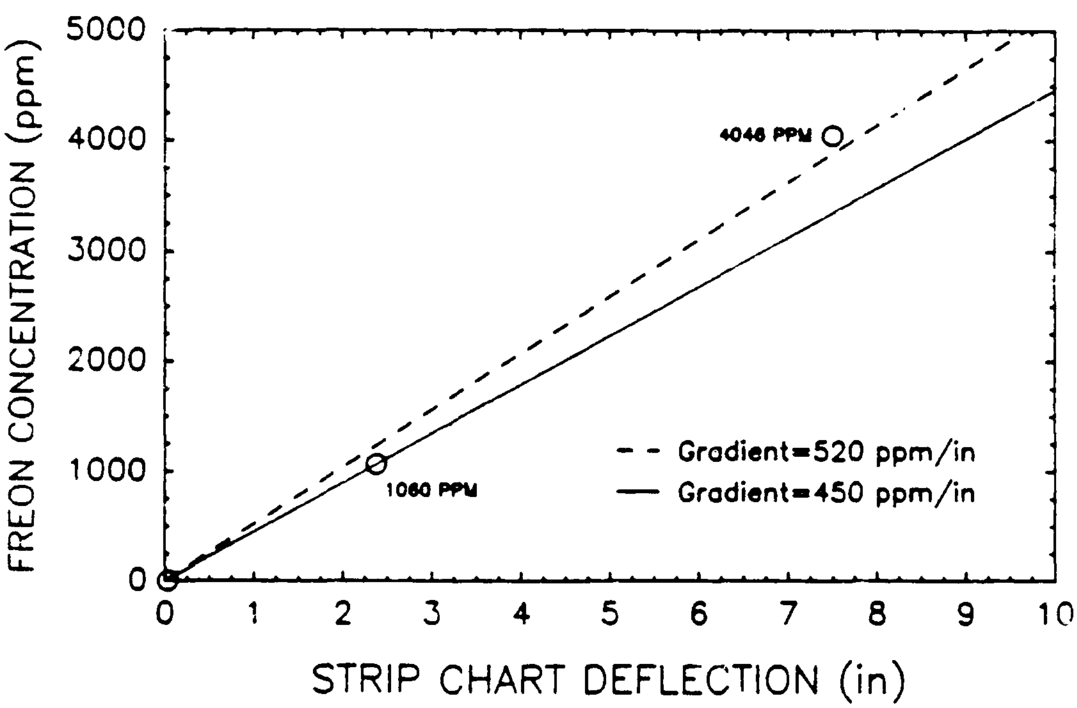

Figure B-38. Results of Calibration 3 of CA 4.

TABLE B-1. ERROR ANALYSIS RESULTS FOR SITE 1.

UNITS:
Z* = ppm-mins
Qi = ppm-mins
EVENT AREA = ppm-mins

							QUANTITIES FOR ERROR ANALYSIS							
TIME	DURATION TIME	NUMBER of EVENTS	MAX EVENT HEIGHTS (raw)	TOTAL SUM OF AREAS FOR EVENT (raw)	TOTAL SUM OF AREAS FOR EVENT (ppm-mins)	EVENT LIFESPAN (minutes	AVERAGE CONVERSION FACTOR fbar (ppm/cm)	ERROR IN fbar (=Dfbar)	FRACTIONAL ERROR IN fbar Dfbar/fbar	FRACTIONAL ERROR IN PEAK HEIGHT	FRACTIONAL ERROR IN REFERENCE AREA Z*	FRACTIONAL ERROR IN RAW READING FOR EVENT AREA Qi	FRACTIONAL TOTAL ERROR IN EVENT AREA	SQUARE OF ABSOLUTE ERROR IN EVENT AREA (ppm-mins)^2
(1)	(2)	(4)	(5)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
1														
9/13														
1000-1100	60	1	5.8	67	3808	5.2	225	25	0.111111	0.1114450	0.116145682	0.05	0.1285255	239590.1314
		2	3	24	1364	4.8	225	25	0.111111	0.1123541	0.116145682	0.05	0.1285255	30742.68561
		3	2.9	27	1535	4.4	225	25	0.111111	0.1124408	0.116145682	0.05	0.1285255	38908.71147
1100-1200	60	0			0		225	25	0.111111	ERR	0.116145682	0.05	0.1285255	0
1200-1300	60	1	14.4	80	4547	9.2	225	25	0.111111	0.1111653	0.116145682	0.05	0.1285255	341585.3956
1300-1400	60	0			0		225	25	0.111111	ERR	0.116145682	0.05	0.1285255	0
1400-1500	60	1	5.2	34	1933	2.8	225	25	0.111111	0.1115263	0.116145682	0.05	0.1285255	61698.86209
1500-1600	60	1	4	42	2387	5.2	225	25	0.111111	0.1118120	0.116145682	0.05	0.1285255	94149.47468
		2	3.2	76	4320	12.4	225	25	0.111111	0.1122043	0.116145682	0.05	0.1285255	308280.8196
1600-1700	60	1	18.8	88	5002	10	225	25	0.111111	0.1111429	0.116145682	0.05	0.1285255	413318.3287
		2	17	378	21486	18	225	25	0.111111	0.1111500	0.116145682	0.05	0.1285255	7626107.449
1700-1800	60	1	4.4	83	4718	4.8	225	25	0.111111	0.1116906	0.116145682	0.05	0.1285255	367684.6548
		2	10.2	57	3240	5.2	225	25	0.111111	0.1112191	0.116145682	0.05	0.1285255	173407.9610
1800-1900	60	1	24.7	123	6992	8	225	25	0.111111	0.1111295	0.116145682	0.05	0.1285255	807475.8517
		2	14.4	88	5002	4.4	225	25	0.111111	0.1111653	0.116145682	0.05	0.1285255	413318.3287
		3	8.3	88	5002	8.8	225	25	0.111111	0.1112742	0.116145682	0.05	0.1285255	413318.3287
1900-2000	60	0			0		225	25	0.111111	ERR	0.116145682	0.05	0.1285255	0
2000-2100	60	1	21.4	109	6196	6.8	225	25	0.111111	0.1111356	0.116145682	0.05	0.1285255	634121.2634
2100-2300	120	0			0		225	25	0.111111	ERR	0.116145682	0.05	0.1285255	0
2300-2400	cal						222	19.5	0.087837	ERR	0.094125588	0.05	0.1090349	0
2400-0100	60	1	10	63	3533	7.6	222	19.5	0.087837	0.0879800	0.094125588	0.05	0.1090349	148420.5373
		2	14.6	220	12339	14.4	222	19.5	0.087837	0.0879045	0.094125588	0.05	0.1090349	1809915.345
0100-0200	60	1	2.6	8	449	1.6	222	19.5	0.087837	0.0899183	0.094125588	0.05	0.1090349	2393.27649
0200-0400	120	0			0		222	19.5	0.087837	ERR	0.094125588	0.05	0.1090349	0
0400-0500	60	1	8.1	63	3533	7.6	222	19.5	0.087837	0.0880544	0.094125588	0.05	0.1090349	148420.5373
		2	6.7	52	2916	6	222	19.5	0.087837	0.0881542	0.094125588	0.05	0.1090349	101115.9317
0500-0600	60	0			0		222	19.5	0.087837	ERR	0.094125588	0.05	0.1090349	0

TABLE B-1. ERROR ANALYSIS RESULTS FOR SITE 1 (CONCLUDED).

TIME (1)	DURATION TIME (2)	NUMBER of EVENTS (4)	MAX EVENT HEIGHTS (raw) (5)	TOTAL SUM OF AREAS FOR EVENT (raw) (7)	TOTAL SUM OF AREAS FOR EVENT (ppm-mins) (8)	EVENT LIFESPAN (minutes (9)	QUANTITIES FOR ERROR ANALYSIS: AVERAGE CONVERSION FACTOR fbar (ppm/cm) (10)	ERROR IN fbar (=Dfbar) (11)	FRACTIONAL ERROR IN fbar Dfbar/fbar (12)	FRACTIONAL ERROR IN PEAK HEIGHT (13)	FRACTIONAL ERROR IN REFERENCE AREA Z* (14)	FRACTIONAL ERROR IN RAW READING FOR EVENT AREA Qi (15)	FRACTIONAL TOTAL ERROR IN EVENT AREA (16)	SQUARE OF ABSOLUTE ERROR IN EVENT AREA (ppm-mins)^2 (17)
0600-0700	60	1	3	50	2804	3.6	222	19.5	0.087837	0.0894050	0.094125588	0.05	0.1090349	93487.36289
		2	4.3	36	2019	4	222	19.5	0.087837	0.0886041	0.094125588	0.05	0.1090349	48463.84892
		3	11.6	27	1514	4.4	222	19.5	0.087837	0.0879435	0.094125588	0.05	0.1090349	27260.91501
0700-0800	60	1	5.2	48	2692	4.4	222	19.5	0.087837	0.0883625	0.094125588	0.05	0.1090349	86157.95364
		2	5	25	1402	3.6	222	19.5	0.087837	0.0884052	0.094125588	0.05	0.1090349	23371.84072
		3	8.7	75	4206	6	222	19.5	0.087837	0.0880256	0.094125588	0.05	0.1090349	210346.5665
0800-0900	60	1	5.5	37	2075	4	222	19.5	0.087837	0.0883070	0.094125588	0.05	0.1090349	51193.67991
		2	3	26	1458	2.8	222	19.5	0.087837	0.0894050	0.094125588	0.05	0.1090349	25278.98292
		3	5.5	37	2075	4	222	19.5	0.087837	0.0883070	0.094125588	0.05	0.1090349	51193.67991
0900-1000	60	0			0		222	19.5	0.087837	ERR	0.094125588	0.05	0.1090349	0
1000-1100	60	1	13.4	136	7627	8	222	19.5	0.087837	0.0879170	0.094125588	0.05	0.1090349	691656.9056
		2	11.5	13	729	4	222	19.5	0.087837	0.0879453	0.094125588	0.05	0.1090349	6319.745731
		3	2.5	24	1346	3.6	222	19.5	0.087837	0.0900859	0.094125588	0.05	0.1090349	21539.48841
1100-1200	60	1	20.2	58	3253	6.4	222	19.5	0.087837	0.0878727	0.094125588	0.05	0.1090349	125796.5955
1200-1300	cal						230	17.7	0.076956	ERR	0.084062160	0.05	0.1004761	0
1300-1400	60	1	3	49	2847	5.6	230	17.7	0.076956	0.0787406	0.084062160	0.05	0.1004761	81836.80245
1400-1500	60	0			0		230	17.7	0.076956	ERR	0.084062160	0.05	0.1004761	0
1500-1600	60	1	11.1	89	5171	10	230	17.7	0.076956	0.0770882	0.084062160	0.05	0.1004761	269983.0538
		2	7.5	60	3486	6.8	230	17.7	0.076956	0.0772447	0.084062160	0.05	0.1004761	122704.0769
1600-1700	60	1	2.3	8	465	1.6	230	17.7	0.076956	0.0799680	0.084062160	0.05	0.1004761	2181.405813
		2	3.3	29	1685	4.4	230	17.7	0.076956	0.0784338	0.084062160	0.05	0.1004761	28665.03576
		3	1.7	20	1162	5.6	230	17.7	0.076956	0.0823854	0.084062160	0.05	0.1004761	13633.78633
1700-1800	60	1	4	80	4648	11.2	230	17.7	0.076956	0.0779650	0.084062160	0.05	0.1004761	218140.5813
		2	3.1	18	1046	2.8	230	17.7	0.076956	0.0786285	0.084062160	0.05	0.1004761	11043.36692
1800-1900	60	1	1.4	15	872	3.6	230	17.7	0.076956	0.0848399	0.084062160	0.05	0.1004761	7669.004811
		2	2.5	12	697	2.4	230	17.7	0.076956	0.0795129	0.084062160	0.05	0.1004761	4908.163079
1900-2000	60	1	2.3	9	523	1.2	230	17.7	0.076956	0.0799680	0.084062160	0.05	0.1004761	2760.841732
2000-2100	60	1	20.9	134	7786	7.2	230	17.7	0.076956	0.0769936	0.084062160	0.05	0.1004761	612020.6684
2100-2200	60	1	25.7	95	5520	5.2	230	17.7	0.076956	0.0769811	0.084062160	0.05	0.1004761	307612.3041
2200-2300	60	1	12.9	42	2440	5.2	230	17.7	0.076956	0.0770540	0.084062160	0.05	0.1004761	60124.99772
2300-2400	60	1	2.9	62	3603	9.2	230	17.7	0.076956	0.0788642	0.084062160	0.05	0.1004761	131020.6866
		2	2.7	69	4009	13.2	230	17.7	0.076956	0.0791532	0.084062160	0.05	0.1004761	162276.1418
					179466									4203.881820

TABLE B-2. ERROR ANALYSIS RESULTS FOR SITE 2.

UNITS:
Z* = ppm-mins
Qi = ppm-mins
EVENT AREA = ppm-mins

TIME (1)	DURATION TIME (2)	NUMBER of EVENTS (4)	MAX EVENT HEIGHTS (raw) (5)	TOTAL SUM OF AREAS FOR EVENT (raw) (7)	TOTAL SUM OF AREAS FOR EVENT (ppm-mins) (8)	EVENT LIFESPAN (minutes) (9)	AVERAGE CONVERSION FACTOR fbar (ppm/cm) (10)	ERROR IN fbar (=Dfbar) (11)	FRACTIONAL ERROR IN fbar Dfbar/fbar (12)	FRACTIONAL ERROR IN PEAK HEIGHT (13)	FRACTIONAL ERROR IN REFERENCE AREA Z* (14)	FRACTIONAL ERROR IN RAW READING FOR EVENT AREA Qi (15)	FRACTIONAL TOTAL ERROR IN EVENT AREA (16)	SQUARE OF ABSOLUTE ERROR IN EVENT AREA (ppm-mins)^2 (17)
peace 2 9/13														
1045-1100	15	1	6.5	26	1814	2	272.5	17.5	0.064220	0.064679	0.0725835	0.05	0.091089	27296.07685
		2	4.2	11	767	2.4	272.5	17.5	0.064220	0.065314	0.0725835	0.05	0.091089	4885.836241
1100-1200	60	0					272.5	17.5	0.064220	ERR	0.0725835	0.05	0.091089	0
1200-1300	60	1	4.2	12	837	1.6	272.5	17.5	0.064220	0.065314	0.0725835	0.05	0.091089	5814.548915
		2	15.4	70	4883	3.2	272.5	17.5	0.064220	0.064302	0.0725835	0.05	0.091089	197856.1783
		3	2.5	14	977	3.2	272.5	17.5	0.064220	0.067262	0.0725835	0.05	0.091089	7914.247134
		4	2.4	7	488	1.6	272.5	17.5	0.064220	0.067514	0.0725835	0.05	0.091089	1978.561783
1300-1400	60	1	2.8	10	698	2	272.5	17.5	0.064220	0.066656	0.0725835	0.05	0.091089	4037.881191
1400-1500	60	1	4.2	10	698	0.8	272.5	17.5	0.064220	0.065314	0.0725835	0.05	0.091089	4037.881191
		2	2.2	7	488	1.2	272.5	17.5	0.064220	0.068123	0.0725835	0.05	0.091089	1978.561783
		3	1.7	8	558	0.8	272.5	17.5	0.064220	0.070634	0.0725835	0.05	0.091089	2584.243962
		4	3	14	977	1.6	272.5	17.5	0.064220	0.066347	0.0725835	0.05	0.091089	7914.247134
		5	6.7	.15	1046	1.2	272.5	17.5	0.064220	0.064652	0.0725835	0.05	0.091089	9085.232679
1500-1600	60	1	1.8	5	349	0.5	272.5	17.5	0.064220	0.069970	0.0725835	0.05	0.091089	1009.470297
1600-1700	60	multi	5.6	76	5302	20.8	272.5	17.5	0.064220	0.064837	0.0725835	0.05	0.091089	233228.0175
		2	1.6	10	698	1.2	272.5	17.5	0.064220	0.071419	0.0725835	0.05	0.091089	4037.881191
		3	4.2	57	3976	4.8	272.5	17.5	0.064220	0.065314	0.0725835	0.05	0.091089	131190.7599
1700-1800	60	1	2.9	15	1046	1.2	272.5	17.5	0.064220	0.066494	0.0725835	0.05	0.091089	9085.232679
		2	3.8	20	1395	1.6	272.5	17.5	0.064220	0.065554	0.0725835	0.05	0.091089	16151.52476
		3	2.7	12	837	0.6	272.5	17.5	0.064220	0.066836	0.0725835	0.05	0.091089	5814.548915
1800-1900	60	1	2.9	8	558	0.4	272.9	17.5	0.064220	0.066494	0.0725835	0.05	0.091089	2584.243962
1900-2000	60	1	2.2	51	3558	0.6	272.5	17.5	0.064220	0.068123	0.0725835	0.05	0.091089	105025.2897
2000-2100	60	0					272.5	17.5	0.064220	ERR	0.0725835	0.05	0.091089	0
2100-2200	60	1	2.1	4	279	0.4	272.5	17.5	0.064220	0.068491	0.0725835	0.05	0.091089	646.0609905
2200-2300	60	0					272.5	17.5	0.064220	ERR	0.0725835	0.05	0.091089	0
2300-2400	60	1	1.8	8	558	0.6	272.5	17.5	0.064220	0.[illegible]970	0.0725835	0.05	0.091089	2584.243962
		2	2.5	9	628	0.6	272.5	17.5	0.064220	0.067262	0.0725835	0.05	0.091089	3270.683764
2400 0010		calib					267.5	17.5	0.065420	ERR	0.0736477	0.05	0.091940	0

TABLE B-2. ERROR ANALYSIS RESULTS FOR SITE 2 (CONTINUED).

							QUANTITIES FOR ERROR ANALYSIS							
TIME (1)	DURATION TIME (2)	NUMBER of EVENTS (4)	MAX EVENT HEIGHTS (raw) (5)	TOTAL SUM OF AREAS FOR EVENT (raw) (7)	TOTAL SUM OF AREAS FOR EVENT (ppm-mins) (8)	EVENT LIFESPAN (minutes) (9)	AVERAGE CONVERSION FACTOR fbar (ppm/cm) (10)	ERROR IN fbar (=Dfbar) (11)	FRACTIONAL ERROR IN fbar Dfbar/fbar (12)	FRACTIONAL ERROR IN PEAK HEIGHT (13)	FRACTIONAL ERROR IN REFERENCE AREA Z* (14)	FRACTIONAL ERROR IN RAW READING FOR EVENT AREA QI (15)	FRACTIONAL TOTAL ERROR IN EVENT AREA (16)	SQUARE OF ABSOLUTE ERROR IN EVENT AREA (ppm-mins)^2 (17)
9/14														
0100-0500	240	0					267.5	17.5	0.065420	ERR	0.0736477	0.05	0.091940	0
0500-0600	60	1	14.5	291	19928	54	267.5	17.5	0.065420	0.065511	0.0736477	0.05	0.091940	3356787.557
0600-0654	54	0					267.5	17.5	0.065420	ERR	0.0736477	0.05	0.091940	0
0654-0800	66	1	6.5	151	10340	34	267.5	17.5	0.065420	0.065871	0.0736477	0.05	0.091940	903840.4494
		2	3.8	56	3835	21.2	267.5	17.5	0.065420	0.066730	0.0736477	0.05	0.091940	124312.2516
		3	21.7	187	12806	6	267.5	17.5	0.065420	0.065461	0.0736477	0.05	0.091940	1386184.670
		4	21.7	205	14038	6	267.5	17.5	0.065420	0.065461	0.0736477	0.05	0.091940	1665887.236
0800-0904	64	1	21.7	227	15545	16	267.5	17.5	0.065420	0.065461	0.0736477	0.05	0.091940	2042629.468
		2	4.6	50	3424	12	267.5	17.5	0.065420	0.066317	0.0736477	0.05	0.091940	99100.96590
		3	4.6	36	2465	4.8	267.5	17.5	0.065420	0.066317	0.0736477	0.05	0.091940	51373.94072
		4	11.6	54	3698	7.2	267.5	17.5	0.065420	0.065562	0.0736477	0.05	0.091940	115591.3666
		5	11.2	99	6780	11.2	267.5	17.5	0.065420	0.065572	0.0736477	0.05	0.091940	388515.4267
		6	7.7	66	4520	13.2	267.5	17.5	0.065420	0.065742	0.0736477	0.05	0.091940	172673.5229
0904-0957	53	multi	6.8	121	8286	17.6	267.5	17.5	0.065420	0.065832	0.0736477	0.05	0.091940	580374.8967
0957-1100	63	1	6	45	3082	6.8	267.5	17.5	0.065420	0.065949	0.0736477	0.05	0.091940	80271.78238
		2	12.3	92	6300	12	267.5	17.5	0.065420	0.065546	0.0736477	0.05	0.091940	335516.2301
		3	7.3	31	2123	11.2	267.5	17.5	0.065420	0.065778	0.0736477	0.05	0.091940	38094.41129
		4	5	54	3698	7.2	267.5	17.5	0.065420	0.066180	0.0736477	0.05	0.091940	115591.3666
		5	8.3	73	4999	8	267.5	17.5	0.065420	0.065697	0.0736477	0.05	0.091940	211243.6189
1100-1200	60	0					226	14	0.061946	ERR	0.0705801	0.05	0.089501	0
1214-1400	106	1	3	15	868	5.2	226	14	0.061946	0.064149	0.0705801	0.05	0.089501	6033.122877
		2	2.5	24	1389	7.2	226	14	0.061946	0.065095	0.0705801	0.05	0.089501	15444.79456
		3	15.4	140	8100	17.2	226	14	0.061946	0.062031	0.0705801	0.05	0.089501	525552.0373
		multi	21.8	1084	62716	49.2	226	14	0.061946	0.061989	0.0705801	0.05	0.089501	31507809.93
1400-1500	60	multi	18.4	575	33267	36	226	14	0.061946	0.062006	0.0705801	0.05	0.089501	8865338.895
		2	4.4	54	3124	8.8	226	14	0.061946	0.062980	0.0705801	0.05	0.089501	78189.27249
		3	7.7	53	3066	4.8	226	14	0.061946	0.062286	0.0705801	0.05	0.089501	75320.18739
1500-1600	60	multi	8.5	262	15158	23.2	226	14	0.061946	0.062225	0.0705801	0.05	0.089501	1840611.941
		2	2.2	43	2488	7.2	226	14	0.061946	0.065984	0.0705801	0.05	0.089501	49578.86311
		multi	6.3	138	7984	20.8	226	14	0.061946	0.062453	0.0705801	0.05	0.089501	510643.5203

TABLE B-2. ERROR ANALYSIS RESULTS FOR SITE 2 (CONCLUDED).

TIME (1)	DURATION TIME (2)	NUMBER of EVENTS (4)	MAX EVENT HEIGHTS (raw) (5)	TOTAL SUM OF AREAS FOR EVENT (raw) (7)	TOTAL SUM OF AREAS FOR EVENT (ppm-mins) (8)	EVENT LIFESPAN (minutes) (9)	QUANTITIES FOR ERROR ANALYSIS: AVERAGE CONVERSION FACTOR fbar (ppm/cm) (10)	ERROR IN fbar (=Dfbar) (11)	FRACTIONAL ERROR IN fbar Dfbar/fbar (12)	FRACTIONAL ERROR IN PEAK HEIGHT (13)	FRACTIONAL ERROR IN REFERENCE AREA Z* (14)	FRACTIONAL ERROR IN RAW READING FOR EVENT AREA Qi (15)	FRACTIONAL TOTAL ERROR IN EVENT AREA (16)	SQUARE OF ABSOLUTE ERROR IN EVENT AREA (ppm-mins)^2 (17)
1600-1800	120	1	4.8	56	3240	7.2	226	14	0.061946	0.062816	0.0705801	0.05	0.089501	84088.32597
		2	4.2	29	1678	4	226	14	0.061946	0.063080	0.0705801	0.05	0.089501	22550.47262
		3	4.5	47	2719	5.6	226	14	0.061946	0.062935	0.0705801	0.05	0.089501	59231.85971
		4	4.5	30	1736	4.4	226	14	0.061946	0.062935	0.0705801	0.05	0.089501	24132.49151
		5	4.4	35	2025	4.8	226	14	0.061946	0.062980	0.0705801	0.05	0.089501	32847.00233
		6	4.3	31	1794	4.8	226	14	0.061946	0.063028	0.0705801	0.05	0.089501	25768.13815
		7	7.3	100	5786	10	226	14	0.061946	0.062324	0.0705801	0.05	0.089501	268138.7945
		8	8.4	142	8216	12	226	14	0.061946	0.062232	0.0705801	0.05	0.089501	540675.0653
		9	2	27	1562	4	226	14	0.061946	0.066801	0.0705801	0.05	0.089501	19547.31812
		10	9.4	88	5091	6.8	226	14	0.061946	0.062174	0.0705801	0.05	0.089501	207646.6825
		11	9.7	65	3761	6	226	14	0.061946	0.062160	0.0705801	0.05	0.089501	113288.6407
1800-1906	66	1	5.2	46	2661	6.8	226	14	0.061946	0.062688	0.0705801	0.05	0.089501	56738.16892
		2	3.7	10	579	2	226	14	0.061946	0.063403	0.0705801	0.05	0.089501	2681.387945
		3	6.2	90	5207	6	226	14	0.061946	0.062469	0.0705801	0.05	0.089501	217192.4235
		4	4.6	96	5554	11.2	226	14	0.061946	0.062893	0.0705801	0.05	0.089501	247116.7130
1906-2000	54	1	5.1	12	694	4	226	14	0.061946	0.062717	0.0705801	0.05	0.089501	3861.198641
		2	7	84	4860	11.2	226	14	0.061946	0.062357	0.0705801	0.05	0.089501	189198.7334
2000-2043	43	0					226	14	0.061946	ERR	0.0705801	0.05	0.089501	0
2043-2200	103	1	3.8	30	1736	7.2	226	14	0.061946	0.063328	0.0705801	0.05	0.089501	24132.49151
		2	4.5	38	2199	9.6	226	14	0.061946	0.062935	0.0705801	0.05	0.089501	38719.24193
		3	7.9	79	4571	6.8	226	14	0.061946	0.062269	0.0705801	0.05	0.089501	167345.4216
		4	3.6	23	1331	4.8	226	14	0.061946	0.063484	0.0705801	0.05	0.089501	14184.54223
		5	5.3	49	2835	6.8	226	14	0.061946	0.062661	0.0705801	0.05	0.089501	64380.12457
2200-2300	60	1	4.1	14	810	1.2	226	14	0.061946	0.063135	0.0705801	0.05	0.089501	5255.520373
		2	6.4	226	13075	20	226	14	0.061946	0.062437	0.0705801	0.05	0.089501	1369545.707
2300-2356	56	1	3.7	58	3356	7.6	226	14	0.061946	0.063403	0.0705801	0.05	0.089501	90201.89048
		2	5.9	111	6422	10.8	226	14	0.061946	0.062523	0.0705801	0.05	0.089501	330373.8087
		3	3.8	55	3182	9.2	226	14	0.061946	0.063328	0.0705801	0.05	0.089501	81111.98535
9/15														
2356-0100	64	1	3.8	24	1389	4	226	14	0.061946	0.063328	0.0705801	0.05	0.089501	15444.79456
		2	3.4	24	1389	2	226	14	0.061946	0.063668	0.0705801	0.05	0.089501	15444.79456
		3	5.2	163	9431	30.8	226	14	0.061946	0.062688	0.0705801	0.05	0.089501	712417.9632
		4	3.1	22	1273	6.4	226	14	0.061946	0.064012	0.0705801	0.05	0.089501	12977.91765
0100-0120	20	1	4	126	7290	5.2	226	14	0.061946	0.063195	0.0705801	0.05	0.089501	425697.1502
					414889									7836.737839

TABLE B-3. ERROR ANALYSIS RESULTS FOR SITE 3.

UNITS:

Z* = ppm-mins
Ql = ppm-mins
EVENT AREA = pp-mins

QUANTITIES FOR ERROR ANALYSIS

TIME (1)	DURATION TIME (2)	NUMBER of EVENTS (4)	MAX EVENT HEIGHTS (raw) (5)	TOTAL SUM OF AREAS FOR EVENT (raw) (7)	TOTAL SUM OF AREAS FOR EVENT (ppm-mins) (8)	EVENT LIFESPAN (minutes) (9)	AVERAGE CONVERSION FACTOR fbar (ppm/cm) (10)	ERROR IN fbar (=Dfbar) (11)	FRACTIONAL ERROR IN fbar Dfbar/fbar (12)	FRACTIONAL ERROR IN PEAK HEIGHT (13)	FRACTIONAL ERROR IN REFERENCE AREA Z* (14)	FRACTIONAL ERROR IN RAW READING FOR EVENT AREA Ql (15)	FRACTIONAL TOTAL ERROR IN EVENT AREA (16)	SQUARE OF ABSOLUTE ERROR IN EVENT AREA (ppm-mins)^2 (17)
#3														
9/13														
1045-1100	15	1	1.3	62	9178	11	620	0	0	0.0384615	0.0338251	0.2	0.2041400	3510608.578
1100-1145	45	1	3	161	23919	43	620	0	0	0.0166666	0.0338251	0.2	0.2041400	23842480.29
Paper Jam														
1315-1400	45	1	1	95	14185	11	620	0	0	0.05	0.0338251	0.2	0.2041400	8384841.975
1400-1420	20	1	1.6	56	8344	9.3	620	0	0	0.03125	0.0338251	0.2	0.2041400	290132..403
1432-1500	28	1	2.8	228	33932	28	620	0	0	0.0178571	0.0338251	0.2	0.2041400	47981540.93
1500-1600	60	1	2.5	320	47560	55	620	0	0	0.02	0.0338251	0.2	0.2041400	94264192.31
1600-2140	340	0	0	0	0	0	620	0	0	0	0.0338251	0.2	0.2041400	0
2230-2400	90	0	0	0	0	0	620	0	0	0	0.0338251	0.2	0.2041400	0
9/14														
2400-0240	160	0	0	0	0	0	620	0	0	0	0.0338251	0.2	0.2041400	0
Paper Jam														
0320-0900	340	0	0	0	0	0	620	0	0	0	0.0338251	0.2	0.2041400	0
Changed Probe														
1542-1600	18	1	2	76	8299	13	455	45	0.098901	0.1020118	0.1045254	0.2	0.2268359	3544021.905
1600-2400	480	0	0	0	0	0	455	45	0.098901	0	0.1045254	0.2	0.2268359	0
9/15														
2400-0300	180	0	0	0	0	0	455	45	0.098901	0	0.1045254	0.2	0.2268359	0
					145417.7									13580.46447

TABLE B-4. ERROR ANALYSIS RESULTS FOR SITE 4.

UNITS:
2* = ppm-mins
Qi = ppm-mins
EVENT AREA=ppm-mins

QUANTITIES FOR ERROR ANALYSIS

TIME (1)	DURATION TIME (2)	NUMBER of EVENTS (4)	MAX EVENT HEIGHTS (raw) (5)	TOTAL SUM OF AREAS FOR EVENT (raw) (7)	TOTAL SUM OF AREAS FOR EVENT (ppm-mins) (8)	EVENT LIFESPAN (minutes) (9)	AVERAGE CONVERSION FACTOR fbar (ppm/cm) (10)	ERROR IN fbar (=Dfbar) (11)	FRACTIONAL ERROR IN fbar Dfbar/fbar (12)	FRACTIONAL ERROR IN PEAK HEIGHT (13)	FRACTIONAL ERROR IN REFERENCE AREA 2* (14)	FRACTIONAL ERROR IN RAW READING FOR EVENT AREA Qi (15)	FRACTIONAL TOTAL ERROR IN EVENT AREA (16)	SQUARE OF ABSOLUTE ERROR IN EVENT AREA (ppm-mins)^2 (17)
4														
9/13														
1045-1145	60	1	0.5	1	102	1.9	425	35	0.0823529	0.1295453	0.0890289	0.05	0.1046668	113.9773550
		2	0.5	1	102	3.75	425	35	0.0823529	0.1295453	0.0890289	0.05	0.1046668	113.9773550
Paper jam														
1315-1400	45	0			0		425	35	0.0823529	0	0.0890289	0.05	0.1046668	0
1400-1500	60	1	8.2	33	3366	5.25	425	35	0.0823529	0.0825783	0.0890289	0.05	0.1046668	124121.3396
		2	1.3	13	1326	3	425	35	0.0823529	0.0908916	0.0890289	0.05	0.1046668	19262.17300
1500-1600	60	0			0		425	35	0.0823529	0	0.0890289	0.05	0.1046668	0
1600-1700	60	1	0.4	2	232	2.6	425	35	0.0823529	0.1496897	0.0890289	0.05	0.1046668	590.1460850
1700-2200	300	0			0		437.5	42	0.096	0	0.1017847	0.05	0.1157114	0
2244-2400	76	0			0		437.5	42	0.096	0	0.1017847	0.05	0.1157114	0
9/14														
2400-0240	160	0			0		437.5	42	0.096	0	0.1017847	0.05	0.1157114	0
Paper jam														
0320-0700	220	0			0		437.5	42	0.096	0	0.1017847	0.05	0.1157114	0
0700-0800	60	1	5.2	15	1792	8.6	437.5	42	0.096	0.0964803	0.1017847	0.05	0.1157114	42992.70627
0800-0900	60	0					437.5	42	0.096	ERR	0.1017847	0.05	0.1157114	0
0900-1000	60	1	5.6	31	3703	4.1	437.5	42	0.096	0.0964143	0.1017847	0.05	0.1157114	183626.6254
		2	2	5	597	2.6	437.5	42	0.096	0.0992018	0.1017847	0.05	0.1157114	4776.967364
1000-1100	60	0			0		437.5	42	0.096	ERR	0.1017847	0.05	0.1157114	0
1100-1200	60	1	3.6	14	1672	1.9	437.5	42	0.096	0.0969994	0.1017847	0.05	0.1:57114	37451.42413
1200-1300	60	1	0.8	5	597	1.7	437.5	42	0.096	0.1145523	0.1017847	0.05	0.1157114	4776.967364
		2	0.9	5	597	3.4	437.5	42	0.096	0.1109162	0.1017847	0.05	0.1157114	4776.967364
1300-1400	60	1	6	17	2135	3.7	460	32	0.0695652	0.0700625	0.0773528	0.05	0.0949339	41092.28663
1400-1434	18	1	2.5	4	502	1.1	460	32	0.0695652	0.0723831	0.0773528	0.05	0.0949339	2275.005488
1500-1542	42	1	4.2	16	2010	2.6	460	32	0.0695652	0.0705765	0.0773528	0.05	0.0949339	36400.08781
		2	0.5	5	628	2.6	460	32	0.0695652	0.1218167	0.0773528	0.05	0.0949339	3554.696075
SWITCHED PROBE OVER TO SITE 3					19363									711.2842944

TABLE B-5. ERROR ANALYSIS RESULTS FOR SITE 5.

UNITS:
Z* = ppm-mins
Qi = ppm-mins
EVENT AREA = ppm-mins

QUANTITIES FOR ERROR ANALYSIS

TIME (1)	DURATION TIME (2)	NUMBER of EVENTS (4)	MAX EVENT HEIGHTS (raw) (5)	TOTAL SUM OF AREAS FOR EVENT (raw) (7)	TOTAL SUM OF AREAS FOR EVENT (ppm-mins) (8)	EVENT LIFESPAN (minutes) (9)	AVERAGE CONVERSION FACTOR fbar (ppm/cm) (10)	ERROR IN fbar (=Dfbar) (11)	FRACTIONAL ERROR IN fbar Dfbar/fbar (12)	FRACTIONAL ERROR IN PEAK HEIGHT (13)	FRACTIONAL ERROR IN REFERENCE AREA Z* (14)	FRACTIONAL ERROR IN RAW READING FOR EVENT AREA Qi (15)	FRACTIONAL TOTAL ERROR IN EVENT AREA (16)	SQUARE OF ABSOLUTE ERROR IN EVENT AREA (ppm-mins)^2 (17)
5														
9/15														
0424-1225	481	0			0		475	35	0.0736842	0	0.0810771	0.05	0.0979923	0
1225-1325	60	1	3.1	17	1938	3.4	475	35	0.0736842	0.0754288	0.0810771	0.05	0.0979923	36065.50517
		2	2.7	5	570	3	475	35	0.0736842	0.0759756	0.0810771	0.05	0.0979923	3119.853389
1325-2030	425	0			0		477.5	34	0.0712041	0	0.0788300	0.05	0.0961414	0
9/16														
2100-0600	540	0			0		477.5	34	0.0712041	0	0.0788300	0.05	0.0961414	0
0600-0700	30	1	3.7	23	2636	8.25	477.5	34	0.0712041	0.0724751	0.0788300	0.05	0.0961414	64216.43334
0700-0900	120	0			0		477.5	34	0.0712041	0	0.0788300	0.05	0.0961414	0
9/17														
1000-0100	900	0			0		477.5	34	0.0712041	0	0.0788300	0.05	0.0961414	0
					5144									321.5614901

TABLE B-6. ERROR ANALYSIS RESULTS FOR SITE 6.

UNITS:
Z* = ppm-mins
Qi = ppm-mins
EVENT AREA = ppm-mins

QUANTITIES FOR ERROR ANALYSIS

TIME (1)	DURATION TIME (2)	NUMBER of EVENTS (4)	MAX EVENT HEIGHTS (raw) (5)	TOTAL SUM OF AREAS FOR EVENT (raw) (7)	TOTAL SUM OF AREAS FOR EVENT (ppm-mins) (8)	EVENT LIFESPAN (minutes) (9)	AVERAGE CONVERSION FACTOR fbar (ppm/cm) (10)	ERROR IN fbar (=Dfbar) (11)	FRACTIONAL ERROR IN fbar Dfbar/fbar (12)	FRACTIONAL ERROR IN PEAK HEIGHT (13)	FRACTIONAL ERROR IN REFERENCE AREA Z* (14)	FRACTIONAL ERROR IN RAW READING FOR EVENT AREA Qi (15)	FRACTIONAL TOTAL ERROR IN EVENT AREA (16)	SQUARE OF ABSOLUTE ERROR IN EVENT AREA (ppm-mins)^2 (17)
6														
9/15														
0700-0800	60	1	16.8	81.5	5946	13.2	285	65.6	0.2301754	0.2301946	0.23264752	0.05	0.2390687	2020833.5096
		2	17.1	90	6566	5.6	285	65.6	0.2301754	0.2301940	0.23264752	0.05	0.2390687	2464338.3534
		3	13.1	35.5	2590	8	285	65.6	0.2301754	0.2302070	0.23264752	0.05	0.2390687	383417.58146
		4	13.1	30.5	2225	3.2	285	65.6	0.2301754	0.2302070	0.23264752	0.05	0.2390687	283018.61151
		5	15.8	36.5	2663	2.6	285	65.6	0.2301754	0.2301971	0.23264752	0.05	0.2390687	405322.81127
0800-0900	60	1	16.4	119	8682	14	285	65.6	0.2301754	0.2301956	0.23264752	0.05	0.2390687	4308332.7682
		2	12	50	3648	10	285	65.6	0.2301754	0.2302131	0.23264752	0.05	0.2390687	760598.25722
		3	13.6	29.5	2152	6.4	285	65.6	0.2301754	0.2302047	0.23264752	0.05	0.2390687	264764.25334
		4	12.6	33.33	2432	4.8	285	65.6	0.2301754	0.2302096	0.23264752	0.05	0.2390687	337976.06452
		5	11.9	26.5	1933	4	285	65.6	0.2301754	0.2302137	0.23264752	0.05	0.2390687	213652.05045
		6	12.8	33.75	2462	4.8	285	65.6	0.2301754	0.2302085	0.23264752	0.05	0.2390687	346547.58094
0900-1000	60	1	5.9	12	876	2.4	285	65.6	0.2301754	0.2303313	0.23264752	0.05	0.2390687	43810.459616
		2	11.9	26.75	1952	4.4	285	65.6	0.2301754	0.2302137	0.23264752	0.05	0.2390687	217702.23617
		3	6.6	28.5	2079	3.2	285	65.6	0.2301754	0.2303000	0.23264752	0.05	0.2390687	247118.37377
		4	11.1	28.5	2079	3.2	285	65.6	0.2301754	0.2302195	0.23264752	0.05	0.2390687	247118.37377
		5	11	31.33	2286	5.6	285	65.6	0.2301754	0.2302203	0.23264752	0.05	0.2390687	298631.83787
1000-1100	60	1	10.7	106.5	7770	14	285	65.6	0.2301754	0.2302228	0.23264752	0.05	0.2390687	3450758.2332
		2	10.15	55	4013	12.4	285	65.6	0.2301754	0.2302281	0.23264752	0.05	0.2390687	920323.89123
		3	10	36	2627	9.2	285	65.6	0.2301754	0.2302297	0.23264752	0.05	0.2390687	394294.13654
1100-1200	60	1	9.9	16	1167	1.6	285	65.6	0.2301754	0.2302308	0.23264752	0.05	0.2390687	77885.261539
		2	9.7	29.5	2152	5.2	285	65.6	0.2301754	0.2302331	0.23264752	0.05	0.2390687	264764.25334
		3	9.6	24.67	1800	6	285	65.6	0.2301754	0.2302343	0.23264752	0.05	0.2390687	185162.74747
		4	9.5	43.5	3174	11.2	285	65.6	0.2301754	0.2302356	0.23264752	0.05	0.2390687	575696.82089
		5	9.3	44	3210	11.6	285	65.6	0.2301754	0.2302382	0.23264752	0.05	0.2390687	589007.29039
1200-1300	60	1	8.6	67.25	4907	5.2	285	65.6	0.2301754	0.2302488	0.23264752	0.05	0.2390687	1375941.2623
		2	8.5	44	3210	11.6	285	65.6	0.2301754	0.2302505	0.23264752	0.05	0.2390687	589007.29039
1300-1400	60	1	8.1	31.5	2298	7	285	65.6	0.2301754	0.2302581	0.23264752	0.05	0.2390687	301881.44829
		2	7.9	35	2554	11.6	285	65.6	0.2301754	0.2302624	0.23264752	0.05	0.2390687	372693.14604
		3	8	119.25	8700	6.8	285	65.6	0.2301754	0.2302602	0.23264752	0.05	0.2390687	4326454.0217
		4	8	96.5	7041	10.8	285	65.6	0.2301754	0.2302602	0.23264752	0.05	0.2390687	2833152.4483
		5	7.9	30	2189	2.8	285	65.6	0.2301754	0.2302624	0.23264752	0.05	0.2390687	273815.3726
		6	7.9	38	2772	7.2	285	65.6	0.2301754	0.2302624	0.23264752	0.05	0.2390687	439321.55337
		7	7.8	74	5399	20.8	285	65.6	0.2301754	0.2302646	0.23264752	0.05	0.2390687	1666014.4226
1400-1500	60	1	7.6	34.3	2503	11.2	285	65.6	0.2301754	0.2302694	0.23264752	0.05	0.2390687	357934.49745
		2	7.5	56	4086	4	285	65.6	0.2301754	0.2302719	0.23264752	0.05	0.2390687	954094.45385

TABLE B-6. ERROR ANALYSIS RESULTS FOR SITE 6 (CONTINUED).

QUANTITIES FOR ERROR ANALYSIS

TIME (1)	DURATION TIME (2)	NUMBER of EVENTS (4)	MAX EVENT HEIGHTS (raw) (5)	TOTAL SUM OF AREAS FOR EVENT (raw) (7)	TOTAL SUM OF AREAS FOR EVENT (ppm-mins) (8)	EVENT LIFESPAN (minutes) (9)	AVERAGE CONVERSION FACTOR fbar (ppm/cm) (10)	ERROR IN fbar (=Dfbar) (11)	FRACTIONAL ERROR IN fbar Dfbar/fbar (12)	FRACTIONAL ERROR IN PEAK HEIGHT (13)	FRACTIONAL ERROR IN REFERENCE AREA 2* (14)	FRACTIONAL ERROR IN RAW READING FOR EVENT AREA Qi (15)	FRACTIONAL TOTAL ERROR IN EVENT AREA (16)	SQUARE OF ABSOLUTE ERROR IN EVENT AREA (ppm-mins)^2 (17)
1500-1600	60	1	7.4	83.67	6105	10	285	65.6	0.2301754	0.2302745	0.23264752	0.05	0.2390687	2129878.6259
		2	7.3	30.67	2238	6.4	285	65.6	0.2301754	0.2302773	0.23264752	0.05	0.2390687	286182.3656
		3	7.2	27.33	1994	5.6	285	65.6	0.2301754	0.2302801	0.23264752	0.05	0.2390687	227245.12784
		4	7.2	28.67	2092	4	285	65.6	0.2301754	0.2302801	0.23264752	0.05	0.2390687	250075.24513
		5	7.1	46.33	3380	5.2	285	65.6	0.2301754	0.2302831	0.23264752	0.05	0.2390687	653040.2018
		6	7.1	78.5	5727	12.8	285	65.6	0.2301754	0.2302831	0.23264752	0.05	0.2390687	1874798.6442
		7	6.9	52	3794	6	285	65.6	0.2301754	0.2302894	0.23264752	0.05	0.2390687	822663.075
		8	6.9	80	5837	28.4	285	65.6	0.2301754	0.2302894	0.23264752	0.05	0.2390687	1947131.5385
1600-1900	180	0					285	65.6	0.2301754	0	0.23264752	0.05	0.2390687	0
1900-2008	68	1	1.7	24	1751	12.8	285	65.6	0.2301754	0.2320469	0.23264752	0.05	0.2390687	175241.83846
2052-2100	8	0					302.5	30.1	0.0995041	0	0.10509620	0.05	0.1186347	0
2100-2200	60	0	0	0	0	0	302.5	30.1	0.0995041	0	0.10509620	0.05	0.1186347	0
2200-2300	60	1	11.7	98	7589	17.2	302.5	30.1	0.0995041	0.0995958	0.10509620	0.05	0.1186347	810600.66933
2300-2400	60	0					302.5	30.1	0.0995041	0	0.10509620	0.05	0.1186347	0
2400-0100	60	1	8.6	91	7047	16.4	302.5	30.1	0.0995041	0.0996738	0.10509620	0.05	0.1186347	698936.29141
0100-0656	356	0					302.5	30.1	0.0995041	0	0.10509620	0.05	0.1186347	0
0656-0800	64	1	12.4	61	4724	12.4	302.5	30.1	0.0995041	0.0995857	0.10509620	0.05	0.1186347	314061.33804
		2	3.8	10	774	2	302.5	30.1	0.0995041	0.1003703	0.10509620	0.05	0.1186347	8440.2402054
		3	11.8	64	4956	16	302.5	30.1	0.0995041	0.0995943	0.10509620	0.05	0.1186347	345712.23881
0800-0900	60	multipl	12.1	502	38875	47.2	302.5	30.1	0.0995041	0.0995898	0.10509620	0.05	0.1186347	21269742.927
0900-1000	60	multipl	11.1	186	14404	26	302.5	30.1	0.0995041	0.0996060	0.10509620	0.05	0.1186347	2919985.5015
1000-1100	60	1	12.3	69	5343	6	302.5	30.1	0.0995041	0.0995871	0.10509620	0.05	0.1186347	401839.83618
1100-1200	60	1	11.2	41	3175	6.8	302.5	30.1	0.0995041	0.0996042	0.10509620	0.05	0.1186347	141880.43785
		2	10.6	48	3717	8	302.5	30.1	0.0995041	0.0996158	0.10509620	0.05	0.1186347	194463.13433
		3	8.5	71	5498	6	302.5	30.1	0.0995041	0.0996778	0.10509620	0.05	0.1186347	425472.50876
		4	11.3	77	5963	16	302.5	30.1	0.0995041	0.0996024	0.10509620	0.05	0.1186347	500421.84178
		5	12.1	35	2710	6	302.5	30.1	0.0995041	0.0995898	0.10509620	0.05	0.1186347	103392.94251
		6	9.8	50	3872	6	302.5	30.1	0.0995041	0.0996348	0.10509620	0.05	0.1186347	211006.00514
		7	8.5	68	5266	16	302.5	30.1	0.0995041	0.0996778	0.10509620	0.05	0.1186347	390276.7071
1200-1249	49	0					302.5	30.1	0.0995041	0	0.10509620	0.05	0.1186347	0

TABLE B-6. ERROR ANALYSIS RESULTS FOR SITE 6 (CONCLUDED).

TIME (1)	DURATION TIME (2)	NUMBER of EVENTS (4)	MAX EVENT HEIGHTS (raw) (5)	TOTAL SUM OF AREAS FOR EVENT (raw) (7)	TOTAL SUM OF AREAS FOR EVENT (ppm-mins) (8)	EVENT LIFESPAN (minutes) (9)	QUANTITIES FOR ERROR ANALYSIS: AVERAGE CONVERSION FACTOR fbar (ppm/cm) (10)	ERROR IN fbar (=Dfbar) (11)	FRACTIONAL ERROR IN fbar Dfbar/fbar (12)	FRACTIONAL ERROR IN PEAK HEIGHT (13)	FRACTIONAL ERROR IN REFERENCE AREA Z* (14)	FRACTIONAL ERROR IN RAW READING FOR EVENT AREA Qi (15)	FRACTIONAL TOTAL ERROR IN EVENT AREA (16)	SQUARE OF ABSOLUTE ERROR IN EVENT AREA (ppm-mins)^2 (17)
1249-1400	71	1	10.8	52	4027	4.4	302.5	30.1	0.0995041	0.0996117	0.10509620	0.05	0.1186347	228224.09516
		2	13	85	6582	5.2	302.5	30.1	0.0995041	0.0995784	0.10509620	0.05	0.1186347	609807.35484
		3	11.2	92	7124	8	302.5	30.1	0.0995041	0.0996042	0.10509620	0.05	0.1186347	714381.93099
		4	11.2	65	5034	7.2	302.5	30.1	0.0995041	0.0996042	0.10509620	0.05	0.1186347	356600.14868
		5	10.4	86	6660	7.2	302.5	30.1	0.0995041	0.0996202	0.10509620	0.05	0.1186347	624240.16559
		6	11.4	185	14326	24	302.5	30.1	0.0995041	0.0996007	0.10509620	0.05	0.1186347	2888672.2103
		7	9.8	14	1084	12	302.5	30.1	0.0995041	0.0996348	0.10509620	0.05	0.1186347	16542.870803
1400-1416	16	1	13.4	66	7139	8.8	422.5	33.6	0.0795266	0.0796141	0.08642120	0.05	0.1024579	534948.88361
1438-1600	82	1	11.4	60	6490	5.6	422.5	33.6	0.0795266	0.0796474	0.08642120	0.05	0.1024579	442106.51538
		2	9.9	39	4218	4	422.5	33.6	0.0795266	0.0796868	0.08642120	0.05	0.1024579	186790.00275
		3	7.2	59	6381	7.6	422.5	33.6	0.0795266	0.0798292	0.08642120	0.05	0.1024579	427492.4389
		4	10.7	107	11573	15.6	422.5	33.6	0.0795266	0.0796637	0.08642120	0.05	0.1024579	1406021.5263
		5	11.5	148	16008	23.2	422.5	33.6	0.0795266	0.0796453	0.08642120	0.05	0.1024579	2689972.5313
		6	15.3	172	18604	18	422.5	33.6	0.0795266	0.0795937	0.08642120	0.05	0.1024579	3633133.0975
1600-1700	60	0					422.5	33.6	0.0795266	0	0.08642120	0.05	0.1024579	0
1700-1800	60	1	3	18	1947	1.6	422.5	33.6	0.0795266	0.0812543	0.08642120	0.05	0.1024579	39789.586384
1800-2100	180	0					422.5	33.6	0.0795266	0	0.08642120	0.05	0.1024579	0
2100-2200	60	1	11.4	93	10059	18	422.5	33.6	0.0795266	0.0796474	0.08642120	0.05	0.1024579	1062160.9032
2200-2300	60	0					422.5	33.6	0.0795266	0	0.08642120	0.05	0.1024579	0
2300-2400	60	1	11.4	93	10059	17.2	422.5	33.6	0.0795266	0.0796474	0.08642120	0.05	0.1024579	1062160.9032
2400-0100	60	1	8.9	104	11249	18.4	422.5	33.6	0.0795266	0.0797248	0.08642120	0.05	0.1024579	1328284.464
					417539									9389

TABLE B-7. ERROR ANALYSIS RESULTS FOR SITE 7.

UNITS:
Z* = ppm-mins
Qi = ppm-mins
EVENT AREA = ppm-mins

TIME (1)	DURATION TIME (2)	NUMBER of EVENTS (4)	MAX EVENT HEIGHTS (raw) (5)	TOTAL SUM OF AREAS FOR EVENT (raw) (7)	TOTAL SUM OF AREAS FOR EVENT (ppm-mins) (8)	EVENT LIFESPAN (minutes) (9)	QUANTITIES FOR ERROR ANALYSIS: AVERAGE CONVERSION FACTOR fbar (ppm/cm) (10)	ERROR IN fbar (-Dfbar) (11)	FRACTIONAL ERROR IN fbar Dfbar/fbar (12)	FRACTIONAL ERROR IN PEAK HEIGHT (13)	FRACTIONAL ERROR IN REFERENCE AREA Z* (14)	FRACTIONAL ERROR IN RAW READING FOR EVENT AREA Qi (15)	FRACTIONAL TOTAL ERROR IN EVENT AREA (16)	SQUARE OF ABSOLUTE ERROR IN EVENT AREA (ppm-mins)^2 (17)
7														
9/15														
0604-0800	116	0			0		240	14.6	0.0608333	0	0.0696048	0.05	0.0887346	0
0800-1000	120	1	24.2	446	27042	34	240	14.6	0.0608333	0.0608684	0.0696048	0.05	0.0887346	5757763.0353
		2	19.8	657	39835	27.2	240	14.6	0.0608333	0.0608857	0.0696048	0.05	0.0887346	12494382.837
1000-1100	60	1	17.7	78	4729	8.5	240	14.6	0.0608333	0.0608988	0.0696048	0.05	0.0887346	176105.64413
1100-1200	60	1	17.2	92	5578	10	240	14.6	0.0608333	0.0609027	0.0696048	0.05	0.0887346	244996.41221
1200-1300	60	1	14.1	116	7033	4	240	14.6	0.0608333	0.0609366	0.0696048	0.05	0.0887346	389493.35098
		2	13.8	37	2243	1.5	240	14.6	0.0608333	0.0609411	0.0696048	0.05	0.0887346	39626.664498
1300-1400	60	1	19.5	228	13824	9	240	14.6	0.0608333	0.0608873	0.0696048	0.05	0.0887346	1504713.3143
1400-1500	60	0			0		240	14.6	0.0608333	0	0.0696048	0.05	0.0887346	0
1500-1600	60	1	17.7	33	2001	1.5	240	14.6	0.0608333	0.0608988	0.0696048	0.05	0.0887346	31521.868253
		2	17.4	76	4608	1	240	14.6	0.0608333	0.0609011	0.0696048	0.05	0.0887346	167190.36826
1600-1900	60	0			0		255	15	0.0588235	0	0.0678553	0.05	0.0873690	0
1940-2132	112	1	22.2	268	17265	13	255	15	0.0588235	0.0588666	0.0678553	0.05	0.0873690	2275308.5425
		2	20.2	462	29763	16	255	15	0.0588235	0.0588755	0.0678553	0.05	0.0873690	6761680.7271
2200-2400	60	0			0		255	15	0.0588235	0	0.0678553	0.05	0.0873690	0
9/16														
2400-1056	656	0			0		255	15	0.0588235	0	0.0678553	0.05	0.0873690	0
1116-1300	104	0			0		222.5	32	0.1438202	0	0.1477443	0.05	0.1576622	0
1300-1400	60	1	18.6	165	9275	10.5	222.5	32	0.1438202	0.1438453	0.1477443	0.05	0.1576622	2138251.8282
1400-1444	44	0			0		222.5	32	0.1438202	0	0.1477443	0.05	0.1576622	0
1444-1700	134	1	16.8	1894	106463	12.6	222.5	32	0.1438202	0.1438510	0.1477443	0.05	0.1576622	281741558.69
1700-2300	360	0			0		222.5	32	0.1438202	0	0.1477443	0.05	0.1576622	0
					269658									17712.215934

TABLE B-8. ERROR ANALYSIS RESULTS FOR SITE 8.

UNITS:
Z* = ppm·mins
Qi = ppm·mins
EVENT AREA = ppm·mins

TIME (1)	DURATION TIME (2)	NUMBER of EVENTS (4)	MAX EVENT HEIGHTS (raw) (5)	TOTAL SUM OF AREAS FOR EVENT (raw) (7)	TOTAL SUM OF AREAS FOR EVENT (ppm·mins) (8)	EVENT LIFESPAN (minutes) (9)	QUANTITIES FOR ERROR ANALYSIS: AVERAGE CONVERSION FACTOR fbar (ppm/cm) (10)	ERROR IN fbar (=Dfbar) (11)	FRACTIONAL ERROR IN fbar Dfbar/fbar (12)	FRACTIONAL ERROR IN PEAK HEIGHT (13)	FRACTIONAL ERROR IN REFERENCE AREA Z* (14)	FRACTIONAL ERROR IN RAW READING FOR EVENT AREA Qi (15)	FRACTIONAL TOTAL ERROR IN EVENT AREA (16)	SQUARE OF ABSOLUTE ERROR IN EVENT AREA (ppm·mins)^2 (17)
8														
9-15														
0700-0800	60	1	17.9	334	21517	6	255	21.2	0.0831372	0.0831841	0.0897549	0.05	0.1052850	5131945.812
0800-0900	60	1	21.7	771	49669	19	255	21.2	0.0831372	0.0831691	0.0897549	0.05	0.1052850	27346256.59
0900-0959	59	multipl	21.3	1129	72731	59	255	21.2	0.0831372	0.0831703	0.0897549	0.05	0.1052850	58637711.48
0959-1100	61	multipl	19.4	776	49991	61	255	21.2	0.0831372	0.0831771	0.0897549	0.05	0.1052850	27702092.23
1100-1200	60	1	5.1	30	1933	6	255	21.2	0.0831372	0.0837133	0.0897549	0.05	0.1052850	41402.98353
1200-1300	60	1	19	86	5540	15	255	21.2	0.0831372	0.0831788	0.0897549	0.05	0.1052850	340240.5180
		2	15.9	40	2577	7	255	21.2	0.0831372	0.0831967	0.0897549	0.05	0.1052850	73605.30406
1300-1400	60	1	19.8	250	16105	18	255	21.2	0.0831372	0.0831755	0.0897549	0.05	0.1052850	2875207.189
1400-1500	60	1	17.2	83	5347	19	255	21.2	0.0831372	0.0831880	0.0897549	0.05	0.1052850	316916.8373
1500-1600	60	1	15.2	86	5540	15	255	21.2	0.0831372	0.0832023	0.0897549	0.05	0.1052850	340240.5180
1600-1700	60	0		0	0		255	21.2	0.0831372	0	0.0897549	0.05	0.1052850	0
1700-1800	60	1	9.8	75	4832	15	255	21.2	0.0831372	0.0832936	0.0897549	0.05	0.1052850	258768.6470
1800-1848	48	0		0	0		255	21.2	0.0831372	0	0.0897549	0.05	0.1052850	0
1920-2000	40	0		0	0		263	23	0.0874524	0	0.0937660	0.05	0.1087247	0
2000-2200	120	1	17.7	356	23653	25	263	23	0.0874524	0.0874980	0.0937660	0.05	0.1087247	6613688.757
2200-2300	60	0		0	0		263	23	0.0874524	0	0.0937660	0.05	0.1087247	0
2300-2400	60	1	15.2	70	4651	17	263	23	0.0874524	0.0875143	0.0937660	0.05	0.1087247	255705.3632
9/16														
2400-0700	480	0		0	0		263	23	0.0874524	0	0.0937660	0.05	0.1087247	0
0700-0800	60	multipl	17.5	312	20730	52	263	23	0.0874524	0.0874991	0.0937660	0.05	0.1087247	5079874.056
0800-0900	60	1	18.5	258	17142	26	263	23	0.0874524	0.0874942	0.0937660	0.05	0.1087247	3473626.897
		2	9.2	83	5515	11	263	23	0.0874524	0.0876211	0.0937660	0.05	0.1087247	359500.8667

TABLE B-8. ERROR ANALYSIS RESULTS FOR SITE 8 (CONCLUDED).

TIME (1)	DURATION TIME (2)	NUMBER of EVENTS (4)	MAX EVENT HEIGHTS (raw) (5)	TOTAL SUM OF AREAS FOR EVENT (raw) (7)	TOTAL SUM OF AREAS FOR EVENT (ppm-mins) (8)	EVENT LIFESPAN (minutes) (9)	QUANTITIES FOR ERROR ANALYSIS: AVERAGE CONVERSION FACTOR fbar (ppm/cm) (10)	ERROR IN fbar (=Dfbar) (11)	FRACTIONAL ERROR IN fbar Dfbar/fbar (12)	FRACTIONAL ERROR IN PEAK HEIGHT (13)	FRACTIONAL ERROR IN REFERENCE AREA Z* (14)	FRACTIONAL ERROR IN RAW REALING FOR EVENT AREA Qi (15)	FRACTIONAL TOTAL ERROR IN EVENT AREA (16)	SQUARE OF ABSOLUTE ERROR IN EVENT AREA (ppm-mins)^2 (17)
0900-1000	60	1	13	24	1595	11	263	23	0.0874524	0.0875370	0.0937660	0.05	0.1087247	30058.42636
1000-1055	55	1	4.5	83	5515	21	263	23	0.0874524	0.0881554	0.0937660	0.05	0.1087247	359500.8667
1140-1200	20	0		0	0		313	27	0.0862619	0	0.0926567	0.05	0.1077695	0
1200-1300	60	0		0	0		313	27	0.0862619	0	0.0926567	0.05	0.1077695	0
1300-1400	60	1	9.8	62	4903	12.5	313	27	0.0862619	0.0864127	0.0926567	0.05	0.1077695	279151.0356
1400-1500	60	1	10.7	77	6089	18	313	27	0.0862619	0.0863884	0.0926567	0.05	0.1077695	430563.6031
1500-1600	60	0		0	0		313	27	0.0862619	0	0.0926567	0.05	0.1077695	0
1600-1700	60	1	10.5	30	2372	7	313	27	0.0862619	0.0863933	0.0926567	0.05	0.1077695	65357.94279
1700-1800	60	1	8.5	18	1423	7	313	27	0.0862619	0.0864623	0.0926567	0.05	0.1077695	23528.85940
		2	10.8	32	2530	6	313	27	0.0862619	0.0863861	0.0926567	0.05	0.1077695	74362.81491
1800-1900	60	1	15.8	462	36532	21	313	27	0.0862619	0.0863200	0.0926567	0.05	0.1077695	15500289.71
1900-2000	60	1	14	60	4744	13	313	27	0.0862619	0.0863358	0.0926567	0.05	0.1077695	261431.7712
9/17														
2000-0120	320	0		0	0		313	27	0.0862619	0	0.0926567	0.05	0.1077695	0
					373175									12485

TABLE B-9. ERROR ANALYSIS RESULTS FOR CA 3.

UNITS:
Z* = ppm-mins
Qi = ppm-mins
EVENT AREA = ppm-mins

TIME (1)	DURATION TIME (2)	MAX EVENT HEIGHTS (cm) (5)	TOTAL SUM OF AREAS FOR EVENT (vernier) (7)	TOTAL SUM OF AREAS FOR EVENT (ppm-mins) (8)	EVENT LIFESPAN (minutes) (9)	AVERAGE CONVERSION FACTOR fbar (ppm/cm) (10)	ERROR IN fbar (-Dfbar) (11)	FRACTIONAL ERROR IN fbar Dfbar/fbar (12)	QUANTITIES FOR ERROR ANALYSIS: FRACTIONAL ERROR IN PEAK HEIGHT (13)	FRACTIONAL ERROR IN REFERENCE AREA Z* (14)	FRACTIONAL ERROR IN RAW READING FOR EVENT AREA Qi (15)	FRACTIONAL TOTAL ERROR IN EVENT AREA (16)	SQUARE OF ABSOLUTE ERROR IN EVENT AREA (ppm-mins)^2 (17)
CA #3													
9/13													
1000-1100	60	2.4	166	5737	60	180	10	0.055555	0.0593333	0.065042758	0.05	0.0852030	238931.8057
1100-1200	60	14	250	8640	60	180	10	0.055555	0.0556702	0.065042758	0.05	0.0852030	541923.2784
1200-1300	60	25.5	400	13824	60	180	10	0.055555	0.0555901	0.065042758	0.05	0.0852030	1387323.592
1300-1400	60	10	372	12856	60	180	10	0.055555	0.0557801	0.065042758	0.05	0.0852030	1199896.175
1400-1500	60	9.4	50	1728	60	180	10	0.055555	0.0558096	0.065042758	0.05	0.0852030	21676.93113
1500-1600	60	11.6	215	7430	60	180	10	0.055555	0.0557225	0.065042758	0.05	0.0852030	400806.4567
1600-1700	60	10	17	588	60	180	10	0.055555	0.0557801	0.065042758	0.05	0.0852030	2505.853239
1700-1800	60	9	120	4147	60	180	10	0.055555	0.0558326	0.065042758	0.05	0.0852030	124859.1233
1800-1900	60	2.9	34	1175	60	180	10	0.055555	0.0581694	0.065042758	0.05	0.0852030	10023.41295
1900-2000	60	15.7	89	3076	60	180	10	0.055555	0.0556467	0.065042758	0.05	0.0852030	68681.18861
2000-2100	60	6.5	157	5426	60	180	10	0.055555	0.0560855	0.065042758	0.05	0.0852030	213725.8702
2100-2200	60	15	184	6359	60	180	10	0.055555	0.0556554	0.065042758	0.05	0.0852030	293557.6722
2200-2300	60	13.3	87	3007	60	180	10						
2300-2400	60	3.9	51	1763	60	180	10	0.055555	0.0570156	0.065042758	0.05	0.0852030	22552.67915
2400-0100	60	8.5	126	4355	60	180	10	0.055555	0.0558661	0.065042758	0.05	0.0852030	137657.1834
0100-0200	60	21.8	161	5564	60	180	10	0.055555	0.0556028	0.065042758	0.05	0.0852030	224755.0927
0330-0400	30	6	159	5342	30	175	15	0.085714	0.0861184	0.092147053	0.05	0.1073316	328797.3251
0400-0500	60	17.5	109	3662	60	175	15	0.085714	0.0857618	0.092147053	0.05	0.1073316	154520.8267
0500-0600	60	10	98	3293	60	175	15	0.085714	0.0858599	0.092147053	0.05	0.1073316	124906.8276
0600-0700	60	16.9	240	8064	60	175	15	0.085714	0.0857653	0.092147053	0.05	0.1073316	749128.8291
0700-0800	60	11	188	6317	60	175	15	0.085714	0.0858347	0.092147053	0.05	0.1073316	459673.7732
0800-0900	60	11.2	259	8702	60	175	15	0.085714	0.0858304	0.092147053	0.05	0.1073316	872435.9547

TABLE B-9. ERROR ANALYSIS RESULTS FOR CA 3 (CONTINUED).

TIME (1)	DURATION TIME (2)	MAX EVENT HEIGHTS (cm) (5)	TOTAL SUM OF AREAS FOR EVENT (vernier) (7)	TOTAL SUM OF AREAS FOR EVENT (ppm·mins) (8)	EVENT LIFESPAN (minutes) (9)	QUANTITIES FOR ERROR ANALYSIS: AVERAGE CONVERSION FACTOR fbar (ppm/cm) (10)	ERROR IN fbar (=Dfbar) (11)	FRACTIONAL ERROR IN fbar Dfbar/fbar (12)	FRACTIONAL ERROR IN PEAK HEIGHT (13)	FRACTIONAL ERROR IN REFERENCE AREA Z* (14)	FRACTIONAL ERROR IN RAW READING FOR EVENT AREA Qi (15)	FRACTIONAL TOTAL ERROR IN EVENT AREA (16)	SQUARE OF ABSOLUTE ERROR IN EVENT AREA (ppm·mins)^2 (17)
0900-1000	60	10.1	133	4469	60	175	15	0.085714	0.0858571	0.092147053	0.05	0.1073316	230057.9836
1000-1100	60	15.5	464	15590	60	175	15	0.085714	0.0857749	0.092147053	0.05	0.1073316	2800077.090
1100-1200	60	9.5	330	·11088	60	175	15	0.085714	0.0858757	0.092147053	0.05	0.1073316	1416321.692
1200-1300	60	15.5	349	11726	60	175	15	0.085714	0.0857749	0.092147053	0.05	0.1073316	1584108.342
1345-1400	15	8.8	18	605	15	175	15	0.085714	0.0859023	0.092147053	0.05	0.1073316	4213.849664
1400-1500	60	4	104	3494	60	175	15	0.085714	0.0866209	0.092147053	0.05	0.1073316	140669.7468
1500-1600	60	6.2	217	7291	60	175	15	0.085714	0.0860928	0.092147053	0.05	0.1073316	612425.8235
1600-1700	60	15.9	301	10114	60	175	15	0.085714	0.0857719	0.092147053	0.05	0.1073316	1178330.226
1700-1800	60	14.5	522	17539	60	175	15	0.085714	0.0857836	0.092147053	0.05	0.1073316	3543847.567
1800-1900	60	2.5	45	1512	60	175	15	0.085714	0.0880166	0.092147053	0.05	0.1073316	26336.56040
1900-2000	60	0.75	21	706	60	175	15	0.085714	0.1085881	0.092147053	0.05	0.1073316	5735.517598
2000-2100	60	2.5	32	1075	60	175	15	0.085714	0.0880166	0.092147053	0.05	0.1073316	13317.84585
2100-2200	60	13	426	14314	60	175	15	0.085714	0.0858005	0.092147053	0.05	0.1073316	2360224.017
2200-2300	60	7.5	144	4838	60	175	15	0.085714	0.0859731	0.092147053	0.05	0.1073316	269686.3785
2300-2400	60	8.5	105	3528	60	175	15	0.085714	0.0859158	0.092147053	0.05	0.1073316	143387.9399
2400-0030	30	19	90	3024	60	175	15	0.085714	0.0857546	0.092147053	0.05	0.1073316	105346.2416
9/15													
0112-0200	48	15.5	337	11000	48	170	20	0.117647	0.1176912	0.122413116	0.05	0.1342161	2179563.683
0200-0300	60	12.6	219	7148	60	170	20	0.117647	0.1177139	0.122413116	0.05	0.1342161	920445.3136
0300-0400	60	30.3	449	14655	60	170	20	0.117647	0.1176586	0.122413116	0.05	0.1342161	3869033.082
0400-0500	60	2	104	3395	60	170	20	0.117647	0.1202739	0.122413116	0.05	0.1342161	207575.6659
0500-0600	60	3.5	7	228	60	170	20	0.117647	0.1185112	0.122413116	0.05	0.1342161	940.3853207
0600-0700	60	16	152	4961	60	170	20	0.117647	0.1176885	0.122413116	0.05	0.1342161	443401.2745
0700-0800	60	16.3	445	14525	60	170	20	0.117647	0.1176870	0.122413116	0.05	0.1342161	3800404.145

TABLE B-9. ERROR ANALYSIS RESULTS FOR CA 3 (CONCLUDED).

						QUANTITIES FOR ERROR ANALYSIS							
TIME (1)	DURATION TIME (2)	MAX EVENT HEIGHTS (cm) (5)	TOTAL SUM OF AREAS FOR EVENT (vernier) (7)	TOTAL SUM OF AREAS FOR EVENT (ppm-mins) (8)	EVENT LIFESPAN (minutes) (9)	AVERAGE CONVERSION FACTOR fbar (ppm/cm) (10)	ERROR IN fbar (=Dfbar) (11)	FRACTIONAL ERROR IN fbar Dfbar/fbar (12)	FRACTIONAL ERROR IN PEAK HEIGHT (13)	FRACTIONAL ERROR IN REFERENCE AREA Z* (14)	FRACTIONAL ERROR IN RAW READING FOR EVENT AREA QI (15)	FRACTIONAL TOTAL ERROR IN EVENT AREA (16)	SQUARE OF ABSOLUTE ERROR IN EVENT AREA (ppm-mins)^2 (17)
0800-0900	60	11.2	92	3003	60	170	20	0.117647	0.1177317	0.122413116	0.05	0.1342161	162437.1705
0900-1000	60	25	322	10510	60	170	20	0.117647	0.1176640	0.122413116	0.05	0.1342161	1989855.338
1000-1100	60	9	268	8748	60	170	20	0.117647	0.1177781	0.122413116	0.05	0.1342161	1378412.964
1100-1200	60	11.5	284	9270	60	170	20	0.117647	0.1177273	0.122413116	0.05	0.1342161	1547912.621
1200-1300	60	10.5	663	21640	60	170	20	0.117647	0.1177433	0.122413116	0.05	0.1342161	8436004.797
1300-1400	60	10.7	225	7344	60	170	20	0.117647	0.1177398	0.122413116	0.05	0.1342161	971571.5686
1400-1500	60	20	293	9564	60	170	20	0.117647	0.1176736	0.122413116	0.05	0.1342161	1647574.273
1500-1600	60	14.3	1080	35251	60	170	20	0.117647	0.1176990	0.122413116	0.05	0.1342161	22385008.94
1600-1700	60	10.9	290	9466	60	170	20	0.117647	0.1177364	0.122413116	0.05	0.1342161	1614008.275
				402675.8									8577.096022

TABLE B-10. ERROR ANALYSIS RESULTS FOR CA 4.

UNITS:
2* = ppm-mins
Qi = ppm-mins
EVENT AREA = ppm-mins

						QUANTITIES FOR ERROR ANALYSIS							
TIME (1)	DURATION TIME (2)	MAX EVENT HEIGHTS (cm) (5)	TOTAL SUM OF AREAS FOR EVENT (raw) (7)	TOTAL SUM OF AREAS FOR EVENT (ppm-mins) (8)	EVENT LIFESPAN (minutes) (9)	AVERAGE CONVERSION FACTOR fbar (ppm/cm) (10)	ERROR IN fbar (=Dfbar) (11)	FRACTIONAL ERROR IN fbar Dfbar/fbar (12)	FRACTIONAL ERROR IN PEAK HEIGHT (13)	FRACTIONAL ERROR IN REFERENCE AREA 2* (14)	FRACTIONAL ERROR IN RAW READING FOR EVENT AREA Qi (15)	FRACTIONAL TOTAL ERROR IN EVENT AREA (16)	SQUARE OF ABSOLUTE ERROR IN EVENT AREA (ppm-mins)^2 (17)
CA 4													
9/15													
1915-2000	45	0	0	0	45	173	27	0.156069	0	0.159692789	0.05	0.1689105	0
2000-2100	60	0	0	0	60	173	27	0.156069	0	0.159692789	0.05	0.1689105	0
2100-2200	60	0	0	0	60	173	27	0.156069	0	0.159692789	0.05	0.1689105	0
2200-2300	60	0	0	0	60	173	27	0.156069	0	0.159692789	0.05	0.1689105	0
2300-2400	60	0	0	0	60	173	27	0.156069	0	0.159692789	0.05	0.1689105	0
9/16													
2400-0100	60	0	0	0	60	173	27	0.156069	0	0.159692789	0.05	0.1689105	0
0100-0200	60	0	0	0	60	173	27	0.156069	0	0.159692789	0.05	0.1689105	0
0200-0300	60	0	0	0	60	173	27	0.156069	0	0.159692789	0.05	0.1689105	0
0300-0400	60	0	0	0	60	173	27	0.156069	0	0.159692789	0.05	0.1689105	0
0400-0500	60	0	0	0	60	173	27	0.156069	0	0.159692789	0.05	0.1689105	0
0500-0600	60	0	0	0	60	173	27	0.156069	0	0.159692789	0.05	0.1689105	0
0600-0700	60	0	0	0	60	173	27	0.156069	0	0.159692789	0.05	0.1689105	0
0700-0800	60	11	136	3543	60	173	27	0.156069	0.1561355	0.159692789	0.05	0.1689105	358150.7485
0800-0848	48	11.3	154	4012	48	173	27	0.156069	0.1561320	0.159692789	0.05	0.1689105	459229.1929
0938-1000	22	0	0	0	22	196	12	0.061224	0	0.069946971	0.05	0.0890032	0
1000-1100	60	18.5	281	8294	60	196	12	0.061224	0.0612841	0.069946971	0.05	0.0890032	544902.2683
1100-1200	60	0.1	50	1476	60	196	12	0.061224	0.5037344	0.069946971	0.05	0.0890032	17252.25960

TABLE B-10. ERROR ANALYSIS RESULTS FOR CA 4 (CONCLUDED).

TIME (1)	DURATION TIME (2)	MAX EVENT HEIGHTS (cm) (5)	TOTAL SUM OF AREAS FOR EVENT (raw) (7)	TOTAL SUM OF AREAS FOR EVENT (ppm-mins) (8)	EVENT LIFESPAN (minutes) (9)	QUANTITIES FOR ERROR ANALYSIS: AVERAGE CONVERSION FACTOR fbar (ppm/cm) (10)	ERROR IN fbar (=Dfbar) (11)	FRACTIONAL ERROR IN fbar Dfbar/fbar (12)	FRACTIONAL ERROR IN PEAK HEIGHT (13)	FRACTIONAL ERROR IN REFERENCE AREA Z* (14)	FRACTIONAL ERROR IN RAW READING FOR EVENT AREA QI (15)	FRACTIONAL TOTAL ERROR IN EVENT AREA (16)	SQUARE OF ABSOLUTE ERROR IN EVENT AREA (ppm-mins)^2 (17)
1200-1300	60	12	586	17296	60	196	12	0.061224	0.0613661	0.069946971	0.05	0.0890032	2369742.775
1300-1400	60	17.4	347	10242	60	196	12	0.061224	0.0612918	0.069946971	0.05	0.0890032	830930.9307
1400-1417	17	11.8	105	3099	17	196	12	0.061224	0.0613709	0.069946971	0.05	0.0890032	76082.46486
changed chart speed at 1417													
1417-1500	43	17.8	332	2057	43	196	12	0.061224	0.0612888	0.069946971	0.05	0.0890032	33505.02515
1500-1600	60	5.2	312	1933	60	196	12	0.061224	0.0619749	0.069946971	0.05	0.0890032	29589.86399
1600-1700	60	0.24	239	1481	60	196	12	0.061224	0.2171433	0.069946971	0.05	0.0890032	17363.19260
1700-1800	60	0.19	170	1053	60	196	12	0.061224	0.2701860	0.069946971	0.05	0.0890032	8784.794845
1800-1900	60	0	0	0	60	196	12	0.061224	0	0.069946971	0.05	0.0890032	0
1900-2000	60	0	0	0	60	196	12	0.061224	0	0.069946971	0.05	0.0890032	0
2000-2100	60	0	0	0	60	196	12	0.061224	0	0.069946971	0.05	0.0890032	0
2100-2200	60	0	0	0	60	196	12	0.061224	0	0.069946971	0.05	0.0890032	0
2200-2253	53	0	0	0	53	196	12	0.061224	0	0.069946971	0.05	0.0890032	0
				54484									2178.424549

REFERENCES

1. Brewer, P., McElligott, A. S., and Ayer, J., Solvent Chemical Inventory of the Newark AFB Building 4 Facility, Acurex Corporation, under EPA Contract 68-02-4285, WA 1/012, February 1989.

2. Infrared Spectral Data from the Sadtler Library of Infrared Spectra of Organic Compounds, 1973. Sadtler Laboratories, Inc., Philadelphia, Pennsylvania.

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